DEVELOPMENT OF A FRAMEWORK FOR SUSTAINABLE CONSTRUCTION WASTE MANAGEMENT. A CASE STUDY OF THE THREE MAJOR LIBYAN CITIES

By

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This work or any part thereof has not previously been submitted in any form to the University or to any other body whether for the purpose of assessment, publication or for any other purpose. Save for any express acknowledgements, references and/or bibliographies cited in the work, I confirm that the intellectual content of the work is the result of my own efforts and no other person.

Signature: *Ashraf Ali* Date: 25 July 2018

ABSTRACT

Construction and Demolition (C&D) waste is one of the most voluminous and harmful categories of solid waste worldwide, comprising 40% of the total volume of global waste. Waste minimisation is essential for sustainable waste management for environmental, social and economic benefits. Libya has particularly egregious C&D waste due to prolific and unregulated construction activities and conflict, and defective C&D waste management. This study presents a framework for sustainable construction and demolition waste management (SC&DWM) in the Libyan context. A critical analysis of different barriers affecting SC&DWM and strategies to overcome them are presented based on a combination of literature review and mixed methods research. During the first phase, questionnaires were distributed face-to-face to four different groups: the general public, two groups of experts and policy maker. The second phase involved a focus group discussion (FGD) to produce additional beneficial supporting data, particularly from experts, in order to strengthen the outcomes of the study. Data analysis revealed that the main barrier to SC&DWM in Libya is the lack of C&D waste management facilities, while the least important barrier was producing unrecyclable materials from construction activities. The key strategy for SC&DWM is increasing awareness of negative impacts of C&D waste and the positive influence of sustainable practices for organizational and national economics. The developed framework presents a coherent and systematic approach and identified strategies that could be used to address these barriers and lead to SC&DWM, including options available for SC&DWM, capacity building, implementation and enforcement and evaluation and reviewing. The practical implication of the findings is that Libyan central government, municipalities and organizations need clear vision, approaches and practices to achieve SC&DWM. To validate this research findings, internal and external sources were adopted. In addition, respondent validation technique was used to evaluate the framework. Respondents believed that this framework tailored to the Libyan circumstances and the framework is appropriate enough to obtain SC&DWM practices in the case study. The study also provides a range of targeted recommendations for SC&DWM in Libya to improve efficiency. Further work is necessary to implement construction waste management and waste management at the industrial level, as well as identifying the actual quantity C&D waste so far, and its composition and distribution in Libya.

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Ashraf Ali, University of Wolverhampton, 2018

DEDICATION

This research is dedicated to all my family and to the souls of my grandparents, my aunts Majida and Raja, and Rabhin Nouh Ali and my father-in-law, Makhfi Selmaoui.

ABBREVIATIONS

ANOVA	Analysis of variance
BREEAM	Building research establishment environmental assessment method
BREW	Business resource efficiency and waste
C&D	Construction and demolition
CD&E	Construction, demolition and excavation
CDM	Construction design management
SC&DWM	Sustainable construction and demolition waste management
Defra	Department for Environment, Food and Rural Affairs
DTIE	UN Division of Technology, Industry and Economics
EGA	Environment General Authority
EPA	Environmental Protection Agency
EQ	Educational qualifications
EU	European Union
FGD	Focus group discussion
GCC	Gulf Cooperation Council
GEA	General Environmental Agency
GPiE&WM	Group of people interested in environment and waste management
IETC	International Environmental Technology Centre
LEED	Leadership in energy and environmental design
MENA	Middle East and North Africa
MSW	Municipal solid waste
MSWM	Municipal solid waste management
MANOVA	Multivariate analysis of variance
NATO	North Atlantic Treaty Organization
PC	Post-conflict (scenario)
PCW	Post-conflict waste
SD	Standard deviation
SEPA	Scottish Environmental Protection Agency
SWM	Solid waste management
SWMP	Site waste management plan
USEPA	US Environmental Protection Agency

UNDP	UN Development Programme
UNEP	UN Environment Programme
Wrap	Waste and Resource Action Programme
WFD	Waste framework directive
WIP	Waste implementation programme
3R	Reuse, recycling and recovery
4R	Reduction, reuse, recycling and recovery

1 GENERAL INTRODUCTION

1.1 Introduction

This chapter outlines the thesis with discussions on the background of study and statement of the problem; it also presents the research questions, aim, objectives, and scope of study and the significance of the research. This is followed by a concise discussion on the anticipations and limitations of the study and how the thesis is structured and ordered. It ends with a list of publications and awards associated with this research.

1.2 Background

Construction and demolition (C&D) waste is one of the major universal sustainability issues. Evidence indicates that about 40% of the total volume of waste produced universally originates from C&D activities (Roach, 2001). In the EU, C&D waste accounts for approximately 25-30% of all kinds of waste arising (European Commission, 2015). According to Lu (2011), construction waste accounts for approximately 35% and 50% of the total quantity of municipal solid waste (MSW) in developed countries and developing countries, respectively. MSW is defined as “the amount of municipal waste generated consists of waste collected by or on behalf of municipal authorities and disposed of through the waste management system” (Eurostat, 2012). Much research has been conducted on construction waste, and the outcome of these studies illustrates the serious adverse effects on each of the following environment, economy and social wellbeing (Khairulzan and Halim, 2006; Ndihokubwayo and Haupt, 2009; Baba and Suratkon, 2017). In developing countries such as those in the African continent, C&D waste is rapidly proliferating due to significant increases in development and urbanisation (Economic Commission for Africa, 2009). For instance, C&D waste arising in Tanzania is about 10 million tons annually (Sabai, 2013). Due to a lack of control and management, the final destination of C&D waste in most developing countries is unpredictable, and generally involves various forms of irresponsible disposal such as fly-tipping (Hora, 2007).

Libya is an example of an African country that has faced difficulties with significant rise in the quantity of solid waste due a fast-increasing population and alterations in consumption patterns with economic development (UNDP, 2007); these general macroeconomic factors have been compounded by widespread destruction and reconstruction associated with the recent civil conflict since 2011. Universally, to deal with constantly and quickly increasing C&D waste, various construction waste management policies have been used to reduce C&D waste generation and increase the rate of recycling (Li, 2013). Nowadays, it is appropriate to take on concepts of sustainable C&D waste management (SC&DWM) to avert the probable harmful effects associated with such waste in terms of the economic, environmental and wellbeing dimensions (Nagapan *et al.* 2012). Therefore, a viable and clear official framework is necessary to achieve adequate governance in solid waste. Many authors state that waste management legislation is one of the most powerful factors to reduce the negative impact of waste on the environment (Jallion and Poon, 2008; Osmani *et al.* 2008; Wang *et al.* 2010; Yuan, 2012). Adjei (2016) points out that while government legislation plays a major role in waste management policy, there are different numerous additional factors involved, for instance cost considerations, firm sustainability planning, client requests, company image and industry benchmarking.

1.3 Problem Statement

Since the mid-2000s there has been a construction boom in Libya, which plays a massive role in national economic and civic life. For instance, as of 2009 it was estimated that at least 50% of existing structures need heavy rehabilitation and/or refurbishment, and a further 15-25% should be demolished as soon as possible (Abukerch, 2009). Since the civil conflict after 2011, post-conflict (PC) C&D waste and infrastructure damage (arising from terrorism, civil conflict and NATO bombing) has exacerbated the urgent need for massive reconstruction. Elzahari *et al.* (2013) stated that more than 45,000 housing units need necessary rehabilitation or rebuilding.

The situation is similar to the case of Lebanon after the Israeli withdrawal in 2006. In the absence of proper waste management, most post-conflict waste (PCW) was sent to landfill. This caused the problem to be exacerbated, resulting in the inability of landfills to absorb these quantities and causing the closure of many sites and the paralysis of waste (and general) infrastructure, causing the accumulation of waste on the streets and in urban areas. To avoid such chaos, integrated solid waste management should be applied to meet national needs in compliance with environmental standards under a legitimate umbrella, with appropriate budgetary and specialised asset arrangement (Khalaf-Kairouz, 2017). The Libya Infrastructure Report (2012) estimated that the Libyan government would spend approximately $200-450 billion (US) for the reconstruction and development of national infrastructure through to 2022. This entails a concomitant escalation of C&D waste, which is mainly disposed in landfills or unauthorised places, causing environment problems such as environment pollution. According to Abukerch (2009), C&D waste generation in Libya is estimated to be between 400-450 kg per capita, and in restricted cases C&D waste was utilised to improve the quality of poor local sandy roads in rural areas and countryside ranches. This would enhance the need for having sustainable waste management to increase the rate of reducing, reusing and recycling C&D waste, thus disposing of waste with the optimum benefit and preventing environmental damage, depletion of natural resources and negative impacts on the economy and society.

As in most developing countries, the solid waste management (SWM) framework in Libya is characterised by an absence of services and treatment, abuse of resources, and inefficient facilities (Abdelnaser *et al.* 2011). Also, Saleh (2005) states that standards and regulation for running SWM management do not exist in the context of Libya. Legislation for the environment and regulation to viably address and handle solid waste in local authorities is not well implemented, and in some cases the level of detail of these regulations is not sufficient even in theory. Eltriki (2013) notes that there are significant requisite components missing for managing solid waste in the Libyan regulatory framework (e.g. infrastructure to enable and facilitate the control, direction or application of regulatory actions for waste management). Furthermore, there is no state waste index of types of waste accepted in landfill, financial instruments do not exist and responsibilities are not clearly defined. Additionally, little research has been conducted in Libya on the C&D waste management. To sum up, the research problem in this thesis incorporates the following sub-problems pertaining to C&D waste management in Libya:

- Increased quantity of C&D wastes produced and accumulated.

- Absence of legislation and regulation of C&D waste to underpin enforcement.
- Absence of data and information on the quantity and quality of C&D waste in Libya.
- Limited knowledge on how C&D waste can be managed sustainably.
- Absence of infrastructure (e.g. recycling plants) and adequate systems for managing C&D waste materials.

Many studies concerned with C&D waste management are targeted to developed countries, which reflects the increased awareness of the importance and benefits of sustainable management for such waste in these countries as well as the fact that they generally have more robust enforcement of regulation and supporting facilities (Abarca-Guerrero *et al.* 2017), there are major gaps concerning differences in waste production in developing countries, including different construction materials and systems, standards, practices and economic considerations (Yahya and Boussabaine, 2006). Mature C&D waste management systems from developed countries thus cannot be imported as blueprints for developing countries, rather specific and dedicated adaptation is necessary.

All these issues highlight the need to fill this gap in understanding waste management in Libya by adopting an empirical study conducted in selected cities nationwide. This study informs the sustainable management of normal and PC/C&D waste arising in developing country. To improve C&D waste management in China, Huang *et al.* (2018) used the following three questions that also fundamentally guide this research: (i) what are the existing C&D waste management policy and current circumstances? (ii) what obstacles may hinder C&D waste management using the reuse, recycling and recovery (3R) principles? (ii) what available solutions can achieve effective C&D waste management?

1.4 Research Aim and Objectives

This research is mostly oriented towards answering the research question by focusing on developing sustainable construction waste management plans in Libya, with the following research aim:

- **To develop a framework for sustainable construction and demolition waste management (SC&DWM) to reduce, reuse, recycle and recover C&D waste.**

In order to achieve this aim, the following research question was formulated:

- **How can construction and demolition (C&D) waste management in Libya be made more sustainable?**

To facilitate answering this study question, four main sub-questions were formulated. The first sub-question is about sources of C&D waste and management practices adopted in developed and developing countries; the second is about the best practice drivers for SC&DWM; the third is about current status of C&D waste in Libya; and the fourth sub-question is about the barriers that may hinder C&D waste management in a sustainable manner in Libya.

- **Q1:** What are sources of C&D waste and kind of practices adopted to manage C&D waste?
- **Q2:** What are the best practice drivers in C&D waste management?
- **Q3:** What is the current situation of C&D waste management in Libya?
- **Q4:** What barriers might hinder the process of sustainable construction waste management?

In order to address the above questions, the following research objectives were established:

1. To carry out a comprehensive literature review on C&D waste management in the global and localised context, and barriers affecting the achievement of SC&DW in developed and developing countries.
2. To carry out a comprehensive literature review on PC/C&D waste management, in order to identify the main barriers facing managing PC/C&D waste, such as that experienced in Libya.
3. To conduct an empirical assessment on current C&D waste management in Libya, and identify the major barriers to adopting sustainable management practices and strategies to overcome through quantitative and qualitative approaches.
4. To develop and evaluate an integrated framework for SC&DWM in the Libya context.
5. To provide a range of targeted recommendations for SC&DWM in Libya so as to achieve greater efficiency and recommend directions for further research.

1.5 Scope and Significance

A detailed description of Libya, the case study area, is outlined in Section 3.1 of this thesis. However, the project study area is restricted to three cities in Libya: Benghazi, Bayda and El Gubba. The rationale for selecting these cities includes safety, proximity and population density. The total population of the three cities equals about one-sixth of the total population of Libya, and they are representative of all Libyan cities in term of their population density (see Figure 5.9), cities size, culture, socio-economic, waste management institution and system. Furthermore, they all have a poor framework for waste and environment management, and their populations continue to increase as a result of births and migration of citizens from small cities and rural areas, quick development, industrialisation. The growing population significantly increasing in the quantity of solid waste in the cities (Gebril, 2011), consequently increasing C&D waste arising as a result of construction activities and conflict, particularly in Benghazi.

This research thus seeks to identify suitable C&D waste management practices tailored to Libyan circumstances based on the authentic conditions on the ground, related to construction and demolition of buildings and assets. For the purpose of this research, the term 'demolition' is inclusive of all activities associated with controlled destruction of the buildings and destruction of the same due to conflict or PC activities. The importance of the study is in identifying the current construction waste management and highlighting the barriers and suggestions for a suitable framework that can be used to minimise construction waste arising and increase the rate of 3R. It is anticipated that the findings and recommendations from this study will have a significant basis for C&D waste management generally, particularly with regard to developing countries, and evidence from the focus group discussion (FGD) appears to support this expectation.

1.6 Expectations and Limitations

As previously stated, the main problem was the lack of literature and secondary data on C&D waste in Libya, as waste management itself is not effectively institutionalised in Libya, as in most developing countries. There were also practical and logistical difficulties in conducting the fieldwork due to the PC situation of the country and general organisational and professional issues experienced in making appointments and arranging for FGD, especially with policymakers, because of the current division between state institutions in Libya. The study was hence focused on how the government can develop C&D waste management in Libya and thus advocate for the 3R of waste resulting from normal construction activities and post-conflict issues, but the difficulties experienced highlight the need for more industry-led studies and initiatives. This lesson identified some barriers that may hinder SC&DWM and strategies to overcome them. However, this study did not deeply address success factors to SC&DWM, nor the composition, percentage and distribution of C&D waste materials generated in the country, and the focus was geared more towards effective policy implementation. However, future research can consider these factors and characteristics using suitable approaches.

1.7 Structure of the Thesis

The thesis is presented in ten chapters. **Chapter 1** is an outline of the research. It begins with a background problem, followed by the research aim, questions, objectives, scope and signification and expectation and limitation of study. **Chapter 2** reviews the literature on the research topics studied. The themes of this part of the study are designed to cover the definitions of construction waste, methods of estimating C&D waste, sources of C&D waste, construction waste arising and management in developed and developing countries, and barriers to SC&DWM. **Chapter 3** covers two main subjects; the location, population, climate and socioeconomic activities of Libya; and the ministries and institutions involved in waste management activities. The more germane information to the research subject is that concerning SWM in Libya, an overview of which is given in the chapter. **Chapter 4** Pilot Study on barriers to sustainable management of PC/C&D Waste and presents the framework for PCW in Libya and steps of conceptual framework development for managing C&D waste resulting from normal activities and conflict in Libya. **Chapter 5** outlines the research methodology adopted to achieving the research aim. In this section the qualitative and quantitative methods adopted in the research and a justification on why the mixed method approach was adopted is presented. Furthermore, how data was gathered and analysed to address the study objectives is also presented. **Chapter 6** presents findings of the quantitative part of the study (questionnaire survey) and **Chapter 7** presents findings of the qualitative part (focus group discussion and analysis). **Chapter 8** then further presents a discussion of the research findings and validation. **Chapter 9** develops the framework for SC&DWM in Libya, while **Chapter 10** presents the conclusions and recommendations from study outcomes. Figure (1.1) shows how thesis is structured to achieve proposed objectives.

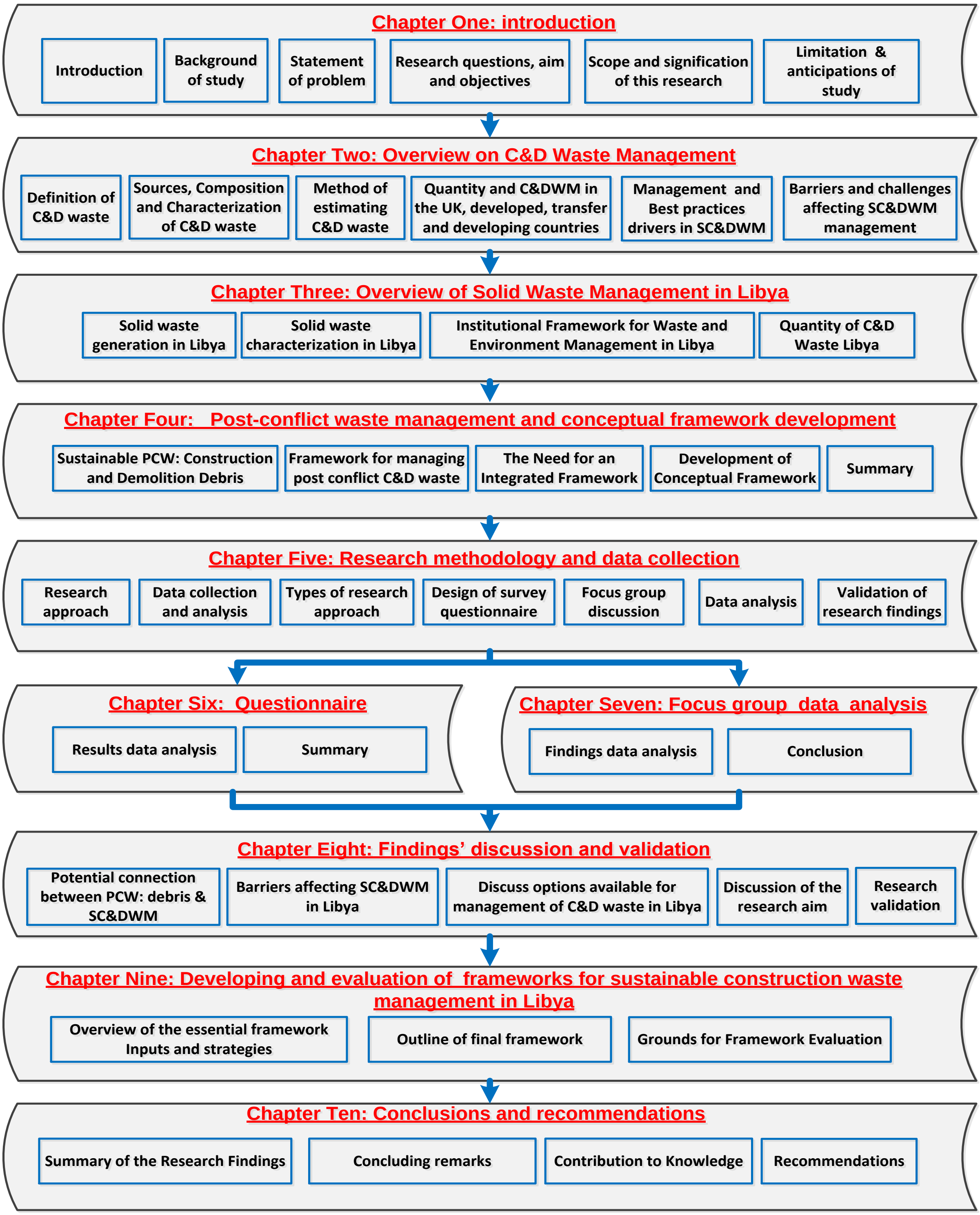


Figure 1-1: Research structure

1.8 List of Publications and Awards

Journal articles

Ali, Ashraf and Ezeah, Chukwunonye. (2017) Framework for management of post-conflict waste Libya. *European Scientific Journal* [online], **13**(5), pp. 32-49. Available at: <http://eujournal.org/index.php/esj/article/view/8856/0>. (published)

Ali, Ashraf., Oloke, David.,Williams, Craig. Ezeah, Chukwunonye.,and Khatib, J. (2017) Implementing sustainable construction and demolition waste management in Libya. *Waste Management and Research*. (submitted)

Ali, Ashraf., Oloke, David., Williams, Craig., Ezeah, Chukwunonye., and Khatib, J. (2017) Transferring and adopting successful sustainable construction waste management practice for Libya. *International Journal of Environmental and Waste Management.* (submitted)

Conference papers

Ali, Ashraf., Ezeah, Chukwunonye., and Khatib, J. (2016) Estimating C&D waste arising in Libya. The 31st International Conference on Solid Waste Technology and Management. Widener University Philadelphia, PA, USA, April 3-6, 2016. (published)

Ali, Ashraf., Oloke, David.,Williams, Craig., Ezeah, Chukwunonye., and Khatib, J. (2017) Opportunities of combining post-conflict and construction waste management in Libya. Conference at Open University, UK (2017) (Abstract)

Ali, Ashraf., Ezeah, Chukwunonye., and Khatib, J. (2016) Development of a framework for sustainable construction and demolition (C&D) waste management in the Libyan context. *Conference: International Workshop on UK Research Collaboration with Kazakhstan (Utilisation and treatment of waste arising from mining activities, oil and other industries),* Almaty, Kazakhstan. (Abstract) (published)

Journal article intended for submission

Ali, Ashraf., Ezeah, Chukwunonye., and Khatib, J. Opportunities of combining post-conflict and construction waste management in Libya. *International Journal of Environmental and Waste Management*

Workshops and seminars

Resource Efficiency and Waste in Construction – 21st September 2017. Warwickshire (UK). Chartered Institution of Wastes Management.

Informal Recycling Sector Workshop – 15th March 2017. University of Leeds (UK).

Evaluation of Environmental and Biological Contamination – 27-28 August 2016. University of Benghazi (Libya).

First International Workshop on Rebuilding Communities for Resilient and Sustainable Development: Eco-Cities – 13-16 December 2015. Aswan (Egypt

Research and Waste Management (RWM) – 15-17 September 2015. National Exhibition Centre, Birmingham (UK).

Academic Awards

- Best research poster at University of Wolverhampton, UK (2017).
- Best research poster in Waste and Resource Management (WaRM) conference at Open University, UK (2017)

2 LITERATURE REVIEW: OVERVIEW ON GLOBAL C&D WASTE

2.1 Introduction

This chapter reviews the literature on C&D waste, mainly concentrating on the definition and historical perspective of C&D waste, its sources, composition and characterisation. The evolution of environmental management and sustainability is traced, and SC&DWM techniques are reviewed, particularly focusing on the barriers to achieving SC&DWM practices. Current practice for C&D waste in developing countries, particularly the Middle East and North Africa (MENA) are reviewed and compared with the UK, as an example of construction waste management in a developed country.

2.2 Definition of Waste

According to Read (2001) there is still much debate among researchers about what is classified as waste, and correspondingly there are many definitions of it, although all converge on the same essentials. However, the precise definition of waste is important because the classification of certain substances as waste is the basis for the formulation of waste management policy and the application of regulatory controls to protect the environment and human health. A number of operational definitions of waste are available for industrial and academic purposes.

According to the new production philosophy, waste should be understood as any inefficiency that results in the use of equipment, materials, labour, or capital in larger quantities than those considered as necessary in the production of a building (inclusive of its whole lifespan and often the demolition phase). Waste includes both the incidence of material losses and the execution of unnecessary work that generates additional costs but does not add value to the product (Koskela, 1992).

A more general definition of waste has been in use in its current wording for over three decades and it is now embedded in the 2008 Waste Framework Directive (WFD) (Directive 2008/98/EC). This set of guidance provides a legal analysis of Article 3(1) which defines "waste" as "any substance or object which the holder discards or intends or is required to discard" (Defra, 2012). This is a general definition for waste, however waste itself can be further differentiated by product types. For example, nuclear waste comprises radioactive substances usually arising as a by-product from nuclear fuel processing plants for electricity generation or research and medicine (Encyclopædia Britannica, 2018). Similarly, construction waste itself includes numerous by-products of several kinds of construction activities. The following section mainly concentrates on the definition of construction waste.

2.3 Definition of Construction Waste

The construction sector is a particularly wasteful economic sector and an egregious offender in environmental terms, thus there have been major efforts to address as construction waste for many years in general terms or as related to particular activities. The Legislative Council Panel (2006) defined construction waste which is illustrated most often as C&D waste substances arising from different construction activities such as excavation, construction, demolition, destruction, renovation and road work, and are often a blend of inert and non-inert materials (e.g. concrete, wood plastic, metal). However, construction waste substances tend to be more homogeneous and are latently easier to sort and recycle, while demolition waste substances tend to be more mixed and contain more hazardous substances, which makes it commensurately harder to sort and recycle. This definition restricts construction waste to solid waste that come from various types of construction activities, which is similar to most mainstream definitions pertaining to landscaping and excavation, demolition and clearance, renovation and road works (Poon *et al.* 2004a; Shen *et al.* 2004; Hao *et al.* 2007).

Researchers have also defined C&D waste in terms of its economic and environmental impacts, including the needless use of natural resources, dispensable costs and environmental harm which could be reduced by improving waste-related ethics (SEPA, 1999). Yahya and Boussabaine (2006) demonstrated economic concerns in their understanding of C&D waste not in the material sense, but as “any losses produced by activities that generate direct or indirect costs but do not add any value to the product from the point of view of the client”.

As shown in Figure (2.1), Nagapan *et al.* (2012) combined the two, categorising C&D waste into physical and nonphysical types, the former of which includes substances lost in construction processes, which are mainly of concern in this research, and the latter of which includes time or cost overruns due to improper waste management in any construction activities such as construction, renovation and demotion. However, according to Elgizawy (2016), the definition of C&D waste is not fixed and differs based on location and type of construction activities, which makes it difficult to find universal solutions to the C&D waste management issue.

Nevertheless, there is no specific definition covering all aspects of C&D waste, and there has been a failure to define C&D waste in a universally accepted or systematic way so far (Lu and Yuan, 2011). When used for systematic or academic purposes, the understanding of C&D waste must be clarified and should include all aspects of C&D activities and the evolving nature of construction management and technologies. Therefore, this study proposed a new definition to fill this gap, understanding C&D waste to comprise: *all direct and indirect material and temporal losses incurred during C&D activities and/or incompatible with the renaissance in technologies and evolving concepts in waste management.*

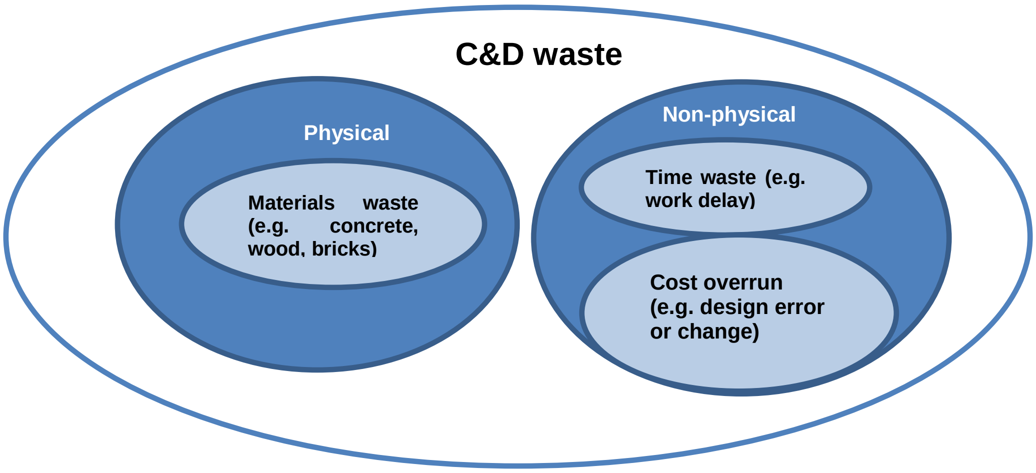


Figure 2-1: Classification of construction waste (Nagapan et al. 2012)

2.4 Historical Perspective of C&D Waste Management

Post-war reconstruction (after WWII) produced and developed many technologies that changed the way construction materials are manufactured (Mincks, 1992). Products required less preparation time for installation, and many were produced in the controlled environment of factories. This did two things for construction materials: first, it provided consistent quality, and second, it allowed for mass production. The panelisation of materials such as plywood and gypsum board were two such innovative improvements which helped change the focus of construction costs. The effect was a higher quality product at a lower price. This transformed the construction industry by placing less emphasis on material wastes and economising on labour costs (Oglesby *et al.* 1989). For example, before gypsum board was used, plaster was the material of choice for wall covering. Plaster is batch-mixed and applied by specialist labourers, with material costs typically twice those of the installation of gypsum board. Gypsum is an abundant resource and is relatively inexpensive compared to the labour required to install it, which is almost treble the cost of the gypsum board itself (Mincks, 1992). However, the relative cheapness of virgin construction materials made it much easier to discard materials from controlled demolition or destruction by earthquakes and conflicts etc., thus the waste produced by the C&D industry increased exponentially during the second half of the 20th century.

Traditional disposal in landfill is no longer viable in many cases due to the volume of waste and the toxicity of many components used in construction (e.g. the widespread use of asbestos from the 1950s-1970s as a low-cost insulating material), requiring pre-treatment or specialist disposal (Patwardhan, 2013). Thus, there is need to recycle and reused as much waste materials as possible to preserve natural resources and alleviate the chronic problems faced by disposal itself.

2.5 Sources, Composition and Characterisation of C&D Waste

In order to achieve the study aim and to cover all matters related to C&D waste management as well as the importance of knowing the sources, composition and characterisation in any kind of waste management. This section of the study investigates sources, composition and characterisation of C&D waste, of which there is in general no specific or fixed conceptualisation. C&D waste can be generated by different sources and causes, at different stages of the construction project. Some can be attributable to errors in the design, before ground was broken on the project site, while others may arise due to on-going modifications or even market trends related to supply chain. Sources of C&D waste can be errors in procurement, operations errors or residual leftover materials on-site, in addition to reordered construction materials or disaster-related wastes (Gavilun and Bernold, 1994; Al-

Ansary, El-Haggar and Taha, 2004); Figure (2.2) provides more details about this classification.

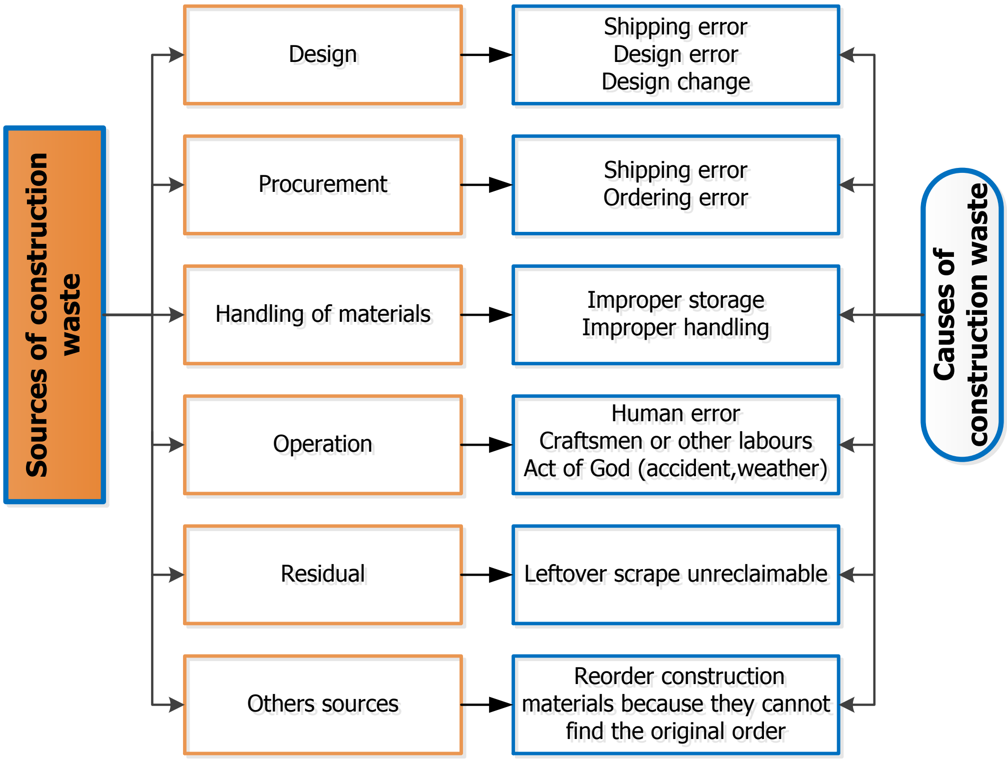


Figure 2-2: Sources of C&D waste
Adapted from Gavilun and Bernold (1994)

According to Li and Sun (2009), C&D waste is considered one of the of the largest sources of solid waste in the world, and contains different types of materials like broken concrete, bricks and masonry, wood and other substances and a huge volume of demolished concrete, bricks and masonry that comprises nearly 90% of all C&D waste (with concrete accounting for 30-40%). Based on EPA reports on C&D waste components in Hong Kong, Schlauder and Brickner (1993) divided the waste into major and minor components, as shown in Table (2.1).

Table 2-1: Major and minor components of C&D waste

Major Components	Minor Components
Cement concrete Bricks Cement plaster Steel (from R>c>c door /window frames, roofing support etc.) Rubble Stone (marble, granite, sand stone) Wood/timber (especially in demolition of old buildings)	Pipes (GI, iron, plastic) Electrical fixture Panels (wooden, laminated) Others (glazed tiles, glass panes, paints etc.)

Source: Schlauder and Brickner (1993)

Pacheco *et al.* (2013) noted that construction, renovation and demolition all produce C&D wastes. Currently, the quantity of waste arising from new constructions is anticipated to be smaller than previously due to the less prevalent use of contaminated materials and the homogenous use of standardised materials and specifications, but waste arising from renovation or demolition activities of legacy buildings produce more hazardous materials. Figure (2.3) shows types of construction waste in demolition sites.

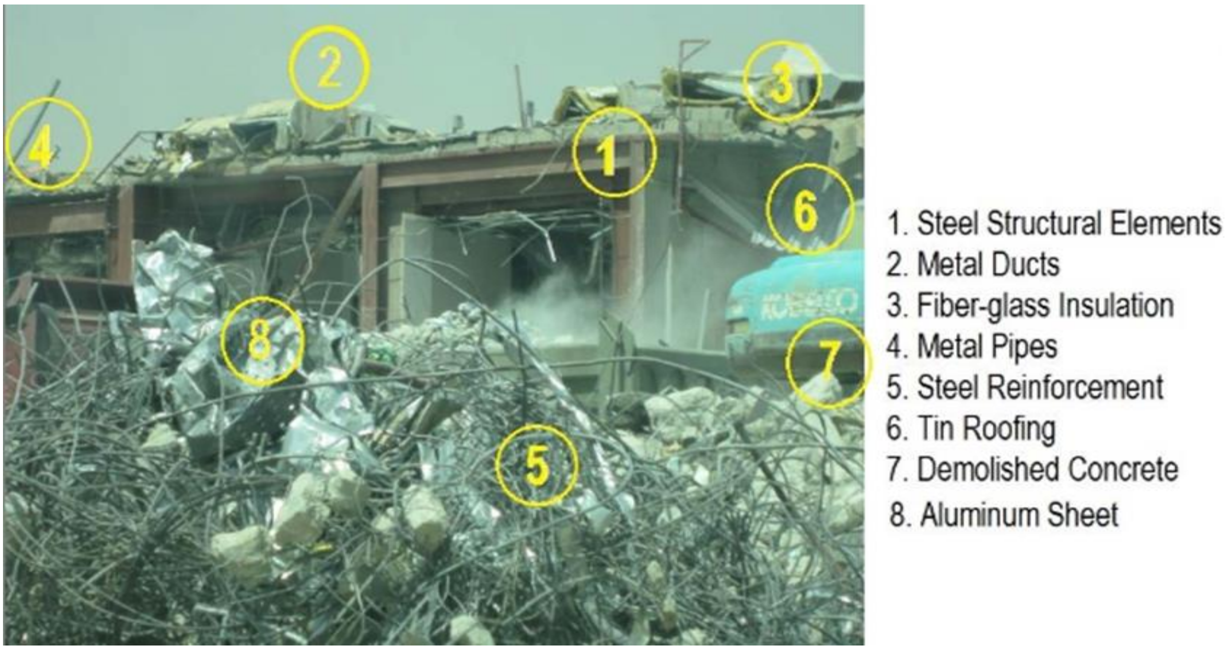
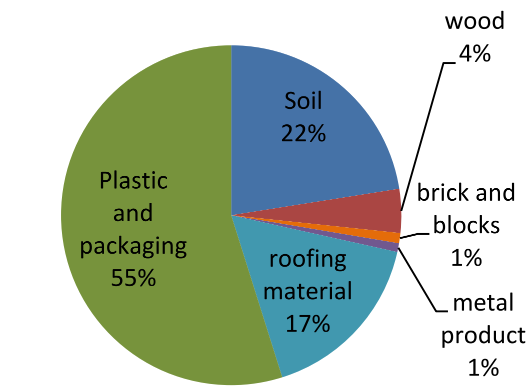
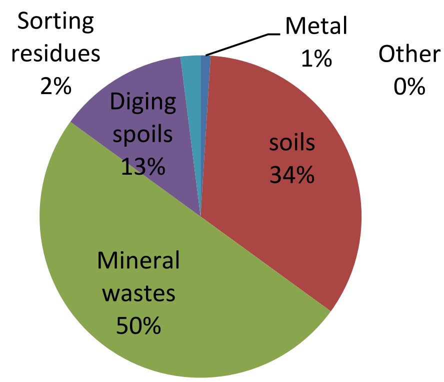


Figure 2-3: Type of waste arising from demolition sites (Kabir et al. 2013)

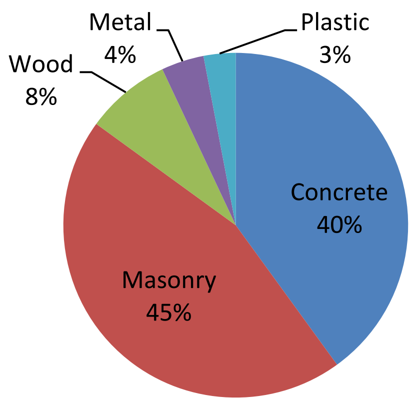
In addition, C&D waste composition is influenced by various components, including raw materials, manufacturing products, architectural typology, geography, definition and C&D practices adopted make it impossible to posit a particular blueprint of C&D waste for all projects in all places (Pacheco, 2013 and Elgizawy *et al.* 2016). Figure (2.4) shows proportions and compositions of C&D waste in different countries, displaying the different C&D waste streams between countries based on the materials used as well as C&D waste definition, which is one of main keys to achieve proper management for C&D waste. For example, C&D waste composition in England included excavation soil as C&D waste, while this is not included as a category in the other countries. This shows the difference in C&D waste definition between the countries and materials used in buildings which can affect the planning management of C&D waste.



C&DW in Malaysia (Begum *et al.* 2007)



C&DW in England (Defra, 2013)



C&DW in Western Europe (Golton, 1997)

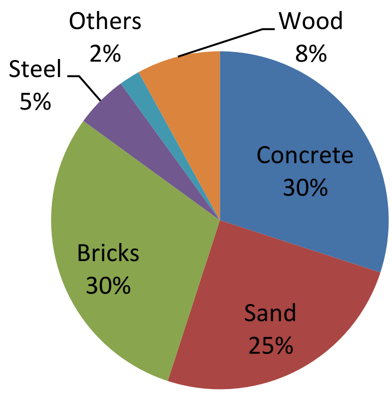


Chart shows the

C&DW in Kuwait (Kartam *et al.* 2004)

Figure 2-4: Compositions of C&D waste in different countries (by weight)

There are different ways to classify C&D waste sources and compositions. According to Burge (1993), characterisation and categorisation are the best ways to grasp of the composition of C&D waste. A new construction, renovation or remodelling, and razing or demolition can be one way to categorise C&D waste. Figure (2.5) shows the partition of the C&D waste and construction, demolition and renovation waste over the EU countries, which shows the big different in the quantity of C&D waste generation between different kinds of construction activities. In addition, Figure (2.6) also shows the impacts of type of construction project on the quantity of construction waste generated. Therefore, Figures (2.4-2.6) show that composition, generation rate and source of C&D waste vary from place to place. Thus, identifying the quantity composition, source and quantity of materials in a waste stream qualifies relevant parties to successfully tailor their waste minimisation plan (USEPA, 2017).

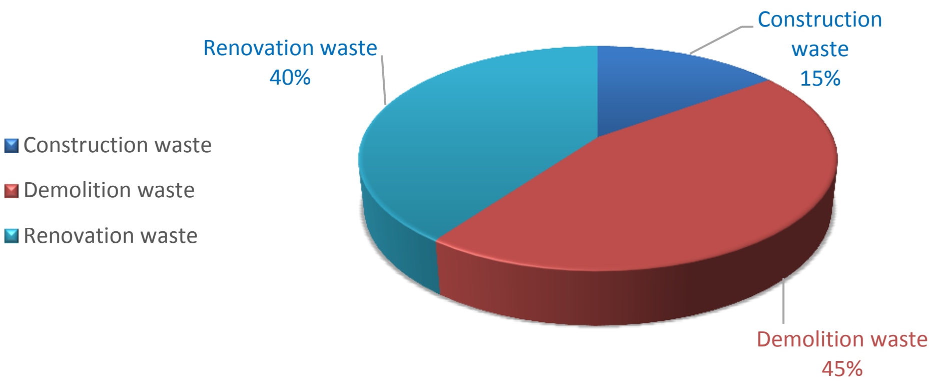


Figure 2-5: Construction and demolition waste in EU
(Symonds Group Ltd, ARGUS, COWI and PRC Bouwcentrum, 1999)

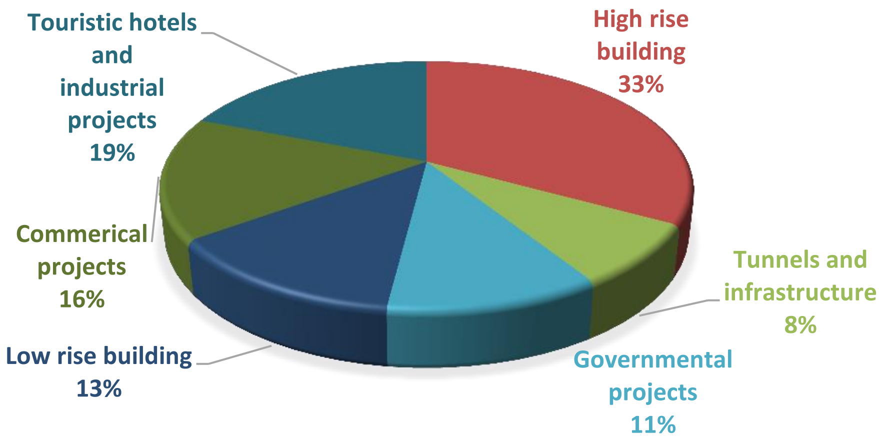


Figure 2-6: Cumulative percentages of projects generating construction waste in Egypt
(El-Haggar, 2007)

According to the Waste and Resources Action Program (Wrap, 2007), C&D waste can be classified and divided into two major categories: waste produced as an outcome of design and specification or waste produced by construction works. Table (2.2) shows some examples of the kind and factors of waste for both categories.

Table 2-2: Major categories waste produced as outcome of design and construction work

Waste produced as outcome of design and specification	Waste produced by construction works
Drylining: cutting of plasterboard sheets and metal studs to fit wall heights and openings Flooring: cuttings of floor tiles to fit room layouts Ceilings: cuttings of ceiling tiles and fixings to fit room layouts Insulation: cutting of insulation boards to fit openings Tiling: cutting of floor and wall tiles to suit design and room shapes Paving: cutting of paving slabs to fit layout Brickwork and blockwork: cuttings of bricks and blocks to suit building dimensions and building services	Inaccurate or surplus ordering of materials that are not used Damage through handling errors Damage through inadequate storage Damage generated by poor co-ordination with other trades Rework due to low quality of work Inefficient use of materials Temporary works materials (e.g. formwork, hoarding etc.)

Source: Wrap (2007)

Therefore, there is no single method for categorising C&D waste, but the most widely recognised one is characterisation by source or beginning, which is seen to be advantageous in light of the fact that it exposes a lot of data about the nature of the waste. Table (2.3) concisely summarises the diverse methods of C&D waste classification.

Table 2-3: Approaches of C&D waste classification

	Methods of C&D waste classification	
	Type of classification	Description
Spivey (1974)	By source/origin	1. Demolition waste (like concrete, brick, wallboard, plaster) 2. Packaging materials (like paper, cardboard, plastic) 3. Wood 4. Waste concrete and asphalt 5. Garbage and sanitary waste 6. Scrap metal 7. Rubber, and glass 8. Pesticides and non-pesticide containers
Symonds Group Ltd (1999)	General types of waste	1. New construction 2. Renovation 3. Demolition
Papadopoulos *et al.* (2003)	By source/origin	1. Waste from excavation 2. Waste from road planning and maintenance materials 3. Waste from demolition materials 4. Worksite waste materials
Skoyle (1976 a, b)	Direct and indirect waste	1. Direct waste: complete loss of a material (inevitable waste involving the necessary replacement of a material) 2. Indirect waste: loss of materials value, to the contractor. These are further subdivided into substitution waste, production waste and negligence waste

Source: Elgizawy *et al.* (2016)

C&D waste is more frequently recognised according to some C&D waste definitions as that generated from activities involving the: construction of buildings and civil infrastructure; complete or partial demolition of buildings and civil infrastructure; and road planning and maintenance. In addition, natural disasters and man-made disasters are also mentioned by many authors as other sources of C&D waste generation (Lauritzen, 1998; Dubey *et al.* 2007). These had not been considered in the previous definitions for C&D waste. Therefore, this study proposed this new definition to fill this gap: *any materials generated from construction activities (e.g. construction, renovation, demolition, excavation) or generated from natural or man-made disasters (e.g. earthquakes, tornadoes, flood, conflicts and terrorist operations), which usually are a mixture of inert and non-inert materials (concrete, wood, plastic)*. This definition is demonstrated in Figure (2.7), which shows the two kinds of sources of C&D waste. Blue boxes illustrate the physical C&D waste, while red boxes illustrate non-physical C&D waste. C&D waste is a global issue and there is increased physical solid C&D waste arising in Libya. Waste is generated in both normal construction activities and PC activities, followed by very poor waste management processes. Proper management of such waste could significantly ameliorate its negative environmental, economic and social consequences (locally and globally). Therefore, this study focusses on physical C&D waste by developing a framework that underpins the management of such waste in a sustainable manner in a developing country, Libya.

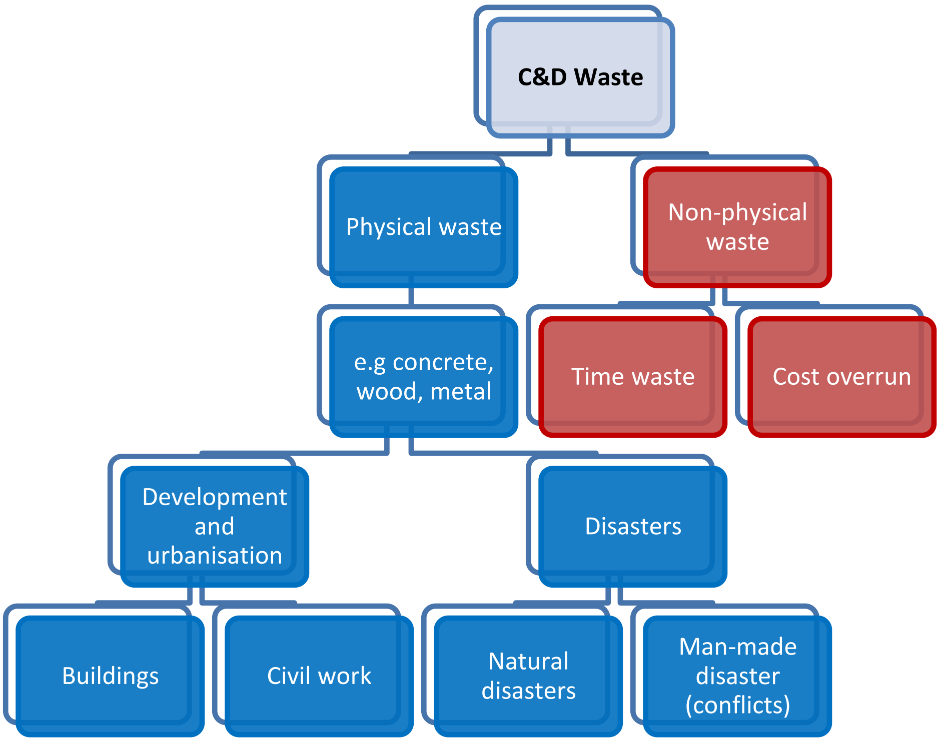


Figure 2-7: Construction and demolition waste classification

2.6 Method of Estimating C&D Waste Arising

Knowing the quantity of C&D waste is one of the main steps toward SC&DWM (Llatas, 2011). This involves determining how much waste is generated in a particular area (Martinez Lage, 2010; Lu *et al.* 2011; Wu *et al.* 2014), since the quantity of production is frequently quoted as a trigger to reflect on environmental issues related to C&D waste (Robles, 2016). Nevertheless, due to differences in sampling and analysis capabilities, the predictions of C&D waste production tend to differ widely between developing and developed countries (Chen *et al.* 2000). This study reviewed methods used to estimate C&D waste arising. This procedure is to help planners and researchers in the selection of the appropriate method for estimating C&D waste arising. C&D waste is one of the waste streams for which information identified with the quantities generated is difficult to acquire (Kourmpanis *et al.* 2008). For this purpose, a number of quantification approaches have been suggested to estimate the waste produced from C&D activities, to assist and achieve appropriate control and administration (Solís-Guzmán *et al.* 2009). Wu *at al*. (2014) noted that there are at least six approaches for estimation of C&D waste, as shown in Figure (2.8).

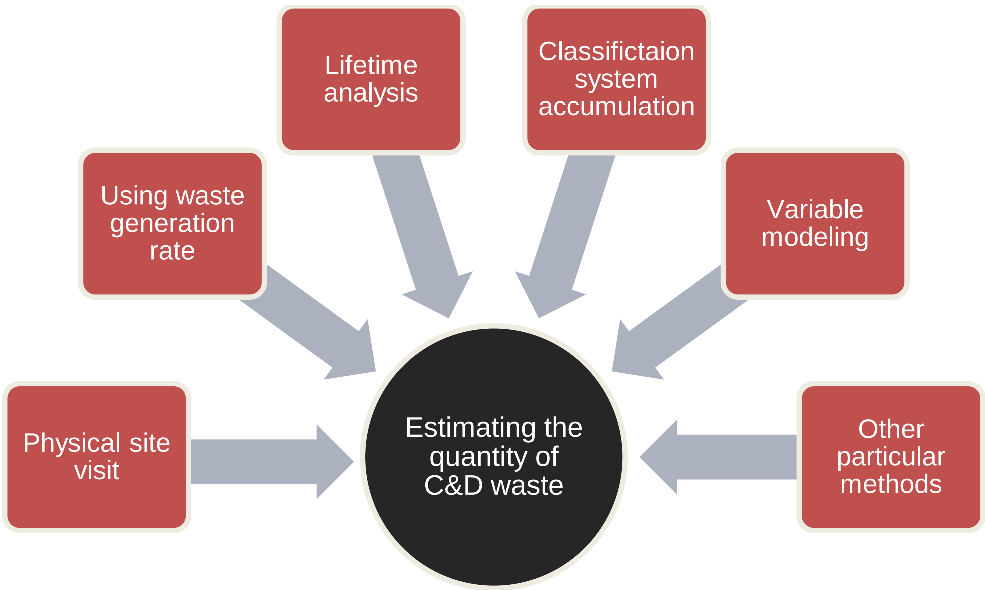


Figure 2-8: Methods of estimation C&D waste arising
Adopted from Wu et al. (2014)

In Europe the initial quantification model was devised in 1976, with a waste quotient of 37 classes of leftover computed by contrasting contractors' reports (Skoyles, 1976). In the US measuring the economic value of waste reflected in construction permits was used to estimate C&D waste by Yost and Halstead (1996); subsequently, this method was adopted by the US Environmental Protection Agency (USEPA) based on computing the C&D waste production as a function of the cross area of construction activities, construction, demolition or renovation (Prairie, 1998).

In the UK, software was created to estimate C&D waste generation based on gathered reference values of new construction projects (SMARTwaste, 2010). In Canada, the programme of work activities in a simulation model of five individual classifications was developed to estimate C&D waste arising in the country (Chandrakanthi *et al.* 2002). Many studies estimated C&D waste arising based on proportion of C&D waste in MSW generation and/or per capita. Cosper *et al.* (1993)

observed that most studies assessed C&D waste to be between 15 and 30% of total MSW. Table (2.4) presents some real examples of applications of these methods to estimate the quantity of C&D waste arising in developed and developing countries. However, these methods have several restrictions, mainly in that their imprecise figures are not always appropriate to develop comprehensive waste administration strategies (Poon *et al.* 2001; Lau *et al.* 2008). For example, some methods consider specific building types (Llatas, 2011), while others are based on statistical information from provincial archives which may not be applicable to other regions with diverse typological types and construction systems; in particular, methods suitable to assay C&D waste in developed nations are often invalid (or less useful) in the context developing ones (Li *et al*. 2013), while some are effective at the project level but not the regional level, and vice-versa (Li and Zhang, 2013).

Table 2-4: Methods of estimating C&D waste arising

Source	Location	Method
Shi and Xu, 2006	China	Based upon the annual figures of cement consumption
Hsiao *et al.* 2002	Taiwan	Forecasting model
Kofoworola and Gheewala, 2009	Thailand	Forecasting model
SMART waste, 2010	UK	Software accounting tools
Li *et al*., 2013	China	Modelled the waste generation per gross floor area employing a mass balance between the purchased quantity of each type of building material and their typical waste material rate
Cheng and Ma, 2013	Hong Kong	Using building information modelling (BIM) technology
Lau *et al.* 2008	Malaysia	Layouts of waste on the construction site
Jalali, 2007	Portugal	Developed indexes covering the typical C&D waste generation as a total or separate fractions
Al Masha'an and Mahrous, 1999	Developing countries	Proportion of C&D waste in MSW generation
El Haggar, 2000	Egypt	Proportion of C&D waste in MSW generation
Hendriks and Pietersen, 2000	EU	Proportion of C&D waste in MSW generation
Ali *et al.* 2016	Libya	Based on the annual figures of cement consumption and Proportion of C&D waste in MSW generation.

2.7 C&D Waste Arising Globally

For successful waste management in the construction sector, waste production is one of the greatest beneficial manners to submit quantitative information for “benchmarking different C&D waste management”. As indicated by information from a World Bank (2012) report, worldwide solid waste arising is expected to increase by 70% between 2010-2025, from more than 3.5 Mt to over 6 Mt per day (Hoornweg and Bhada-tata, 2012). As characterised in the Handbook of Solid Waste

Administration (Tchobanoglous and Kreith, 2002), the sources of solid waste production are household waste, C&D waste, commercial waste, institutional waste, MSW, manufacturing waste, horticultural waste and treatment plant waste. C&D waste symbolises one of the greatest shares of the solid waste in all nations. Figure (2.9) shows the proportion of waste generation in the UK, which presents the construction, demolition and excavation waste (CD&E) produced, approximately more than 50 % of waste generated in the country (Defra, 2016).

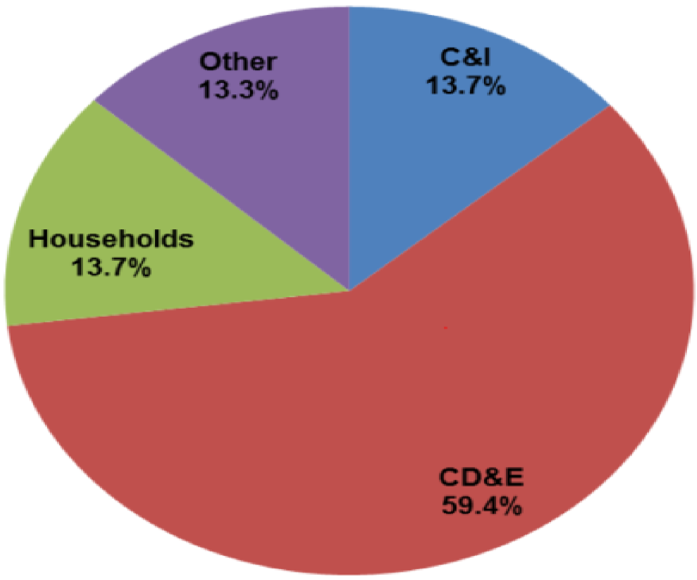


Figure 2-9: Solid waste generation in the UK

Quantitative evidence reveals that almost 40% of the total volume of waste produced globally creates from C&D activities (Roach, 2001). C&D wastes account for more than 10 percent of all waste produced globally (Begum *et al.* 2009). In the EU C&D waste accounts for 25-30% of total waste arising (European Commission [EC], 2015). Table (2.5) illustrates the quantity of C&D waste arising in all EU member states. According to Chan *et al.* (2000), C&D waste in Japan rose from about 25 million tons in 1990 to 71 million tons in 1995, which represents a net increase in C&D waste by around 300 percent.

Table 2-5: Quantity of C&D waste arising in EU

Source	Total C&D waste arising (million tonnes)	C&D waste per capita
WBCSD 2009] (2002 data)	510	1.1
[ETC/RWM 2009](2004 data)	866	1.8
[EUROSTAT 2010] (2006 data)	970	2.0

Source: European Commission (2011)

In Canada, it is estimated that the construction industry produces around 9 Mt of C&D waste per annum, which comprises nearly 35 percent of solid waste flow in the country (Yeheyis *et al.* 2013). The US construction industry produces more than 100 Mt of C&D waste annually. Lauuritzen and Hahn (1992) estimated the entire production quantity of construction waste produced in many developed countries is between 500-100 kg per person annually.

Given that developed countries, which have more stringent regulations and more mature infrastructure development, are producing increasing quantities of C&D waste, the situation can be expected to be even more egregious in developing countries, where short-term profitability is often the overriding concern of C&D projects, with lax regulation and weak governance generally (Ghoddousi *et al.* 2015). Even the most prosperous countries in MENA, those of the Gulf Cooperation Council (GCC), produce nearly 80 million tons of waste annually, 53% of which is C&D waste (Kabir, 2016). Meibodi *et al.* (2015) reported that construction waste has become a serious environmental issue in many countries worldwide. For example, Tehran generated 50,000 tonnes of construction waste per day in 2010, representing about 4.64 kg per person daily (Saghafi and Teshnizi, 2011). It is estimated that C&D waste is becoming one of the biggest waste flows, representing over eight times more volume than SWM in China (Yuan and Shen, 2011). According to Tchobanoglous *et al.* (1993), the apportionment of the quantities of waste differ from country to country. Based on the income variation, countries with low income generate more organic waste than middle-income and upper-income economies, while high income economies generate more inorganic waste.

According to the Economic Commission for Africa (2009) in Africa, C&D waste is quickly mounting on account of considerable rises in development and urbanisation. For example, in Tanzania C&D waste arising increased from 6.6 Mt in 1994 to 17 Mt in 2010, which is around 166% over 16 years.

Despite the fact that the vast volumes of C&D waste generated are expressed and universally acknowledged as a conspicuous issue facing policy makers and the international community as well as particular construction industries, the recognition of precise figures is not an easy task because of different (and often incompatible) data of C&D waste production and treatment, and indeed the absence of modest definition for C&D waste flow amongst nations (Sonigo *et al.* 2010; Rodríguez-Robles *et al.* 2015). Also, the differences in the quantities of C&D waste can be derived from variances in building materials, practices and geology/geography. In addition, the economic variations within the sector can be one of the major influences in C&D waste production (Kourmpanis *et al.* 2008; Fischer and Werge, 2009).

2.8 C&D Waste Arising in the UK

In view of 2010 data, the UK utilises roughly 540 Mt of material resources annually, while more than 259 Mt of resources are discarded annually. Moreover, C&D waste activities in the UK produced over 150 Mt of waste in 1998, which include 40 percent manufactured products and 60 percent from construction sites, including 13 Mt unutilised materials (Smith *et al.* 2003). Figure (2.10) shows waste generation and management in the UK, demonstrating the amount of materials used and the corresponding kinds of waste generated. Its inclusion of C&D indicates the massive volume of total waste contributed by C&D, mandating sustainable management for such waste in the UK and all countries.

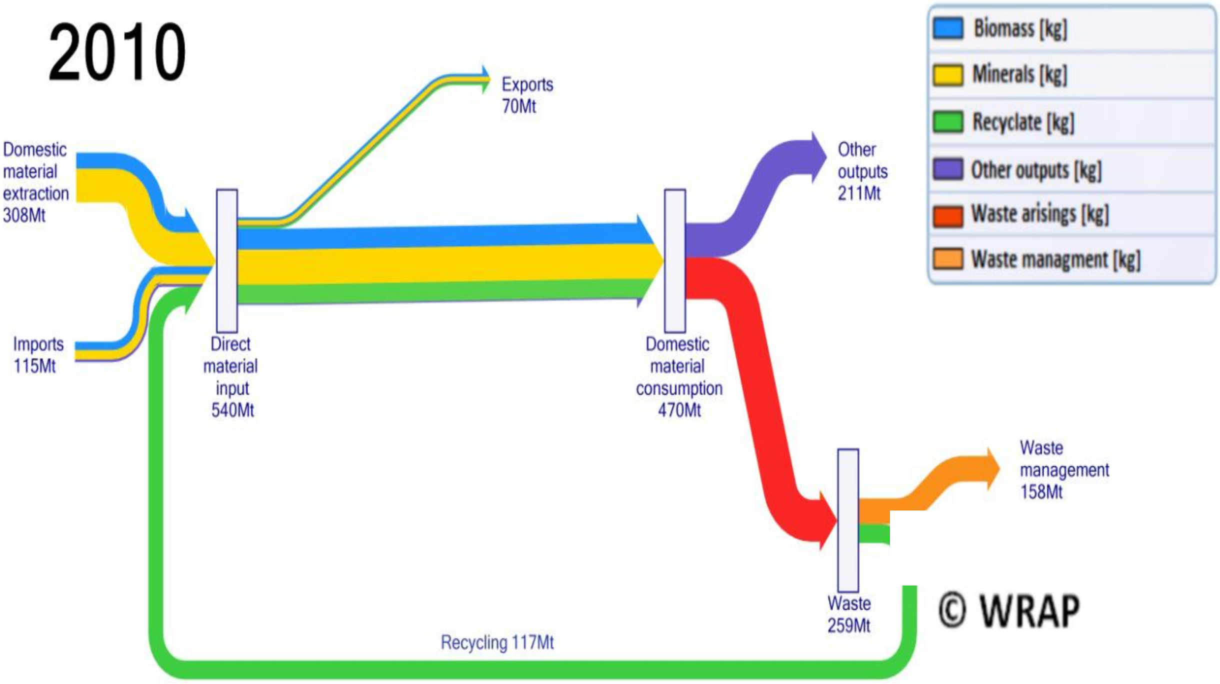


Figure 2-10: Waste generation and management in the UKUs (Defra, 2013)

C&D was the greatest contributor of generated waste in the UK (81.4 Mt), followed by mining and quarrying (62.9 Mt) then the commercial and industrial sector (56.0 Mt), household sources (25.9 Mt) and mixed (1.7 Mt). Figure (2.11) illustrates the total waste generated by sector over 9 years, from 2004 to 2012 (Defra, 2015).

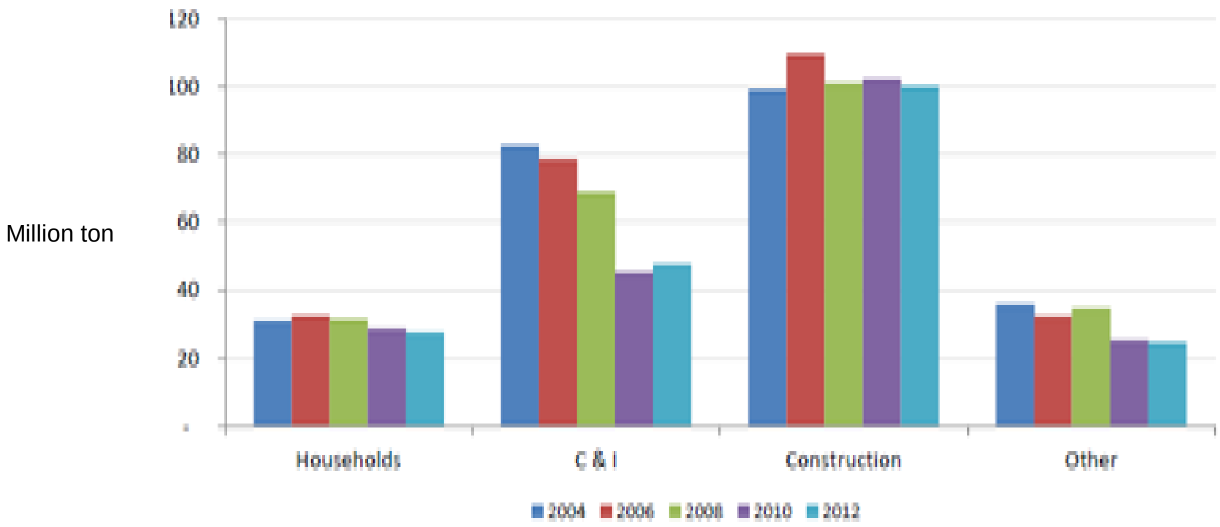


Figure 2-11: Waste arising in the UK (millions of tonnes)

Furthermore, Figure (2.12) illustrates waste arising by sector in the UK and EU-27 in the same year.

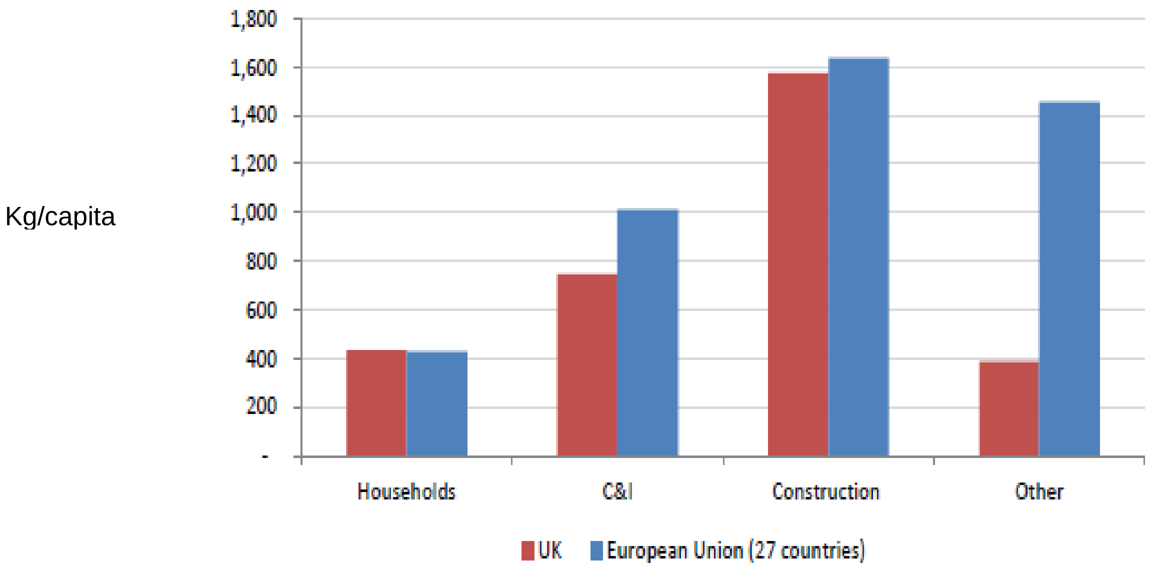


Figure 2-12: UK and EU-27 waste types (kg/capita)
(Eurostat, 2012)

In the UK, 50% of 200.0 Mt waste generated in 2012 was produced by C&D (Defra, 2015). While it can be seen from Figure (2.11) that all types of waste generally declined from 2006 to 2012, this includes the economic recession and slowdown from 2008 onwards, but significant governmental and efforts to reduce waste can be discerned in the decline prior to 2008; for instance, the waste generated declined from 113.2 Mt in 2004 to 109.5 Mt in 2006, and then 101.1 Mt in 2008 (Defra, 2011). However, one should not be deceived into believing this structural reduction (i.e. irrespective of macro-economic and industrial contingencies) means that the problem is solved, as this still comprises immense volumes of cumulative waste. According to Defra (2016), C&D waste of 120.4 Mt in 2014 contributed more than 50% of all landfill.

2.9 C&D Waste Arising in Developing Countries and MENA

The quantities of waste generated in individual construction sites is significant, and their net impact is formidable (Ajayi *et al.* 2008). In developing countries, C&D wastes comprise 20-30% of yearly solid wastes (Al Masha'an and Mahrous, 1999). Studies have illustrated different waste ratios between developed and developing countries (Al-Moghany, 2006). Lu *et al.* (2011) found that the main quantity of MSW comprising C&D waste was 35% in developed countries and 50% in developing, but this is affected by measurements and definitions, as mentioned previously. For instance, construction waste is considered a type of industrial waste in Taiwan, where 16.32 Mt of construction waste produced in 2000 comprised 4.73 Mt landfill and 11.59 Mt was reused and recycled (Tsai and Chou, 2004).

Construction waste is seen primarily as a form of MSW in Thailand, where net MSW production grew from 11.2 Mt in 1993 to 14.3 Mt in 2002. Moreover, the average per person production proportion increased from 0.53 kilogram per person daily in 1993 to 0.62 in 2002. This is due to many reasons such as development, technology, human mentality and population (Chiemchaisri *et al.* 2007).

South Africa is one of the few countries in Africa that has made substantive steps toward more sustainable waste management (Kirsten Barnes, 2017). Construction waste is viewed as one type of the overall waste in South Africa. It was found that in 2002 South Africa produced 5 to 8 Mt of C&D waste, of which 1.4Mt were sent to landfills; based on the increasing number of construction projects, Mwesigye *et al.* (2009) estimated that C&D waste had probably risen to 8-12 Mt yearly in 2007.

According to the South Africa Department of Environmental Affairs (2012), C&D waste sent to landfill during the previous five years was as shown in Figure (2.13). Clearly only 649.000 tonnes of C&D waste was sent to landfill in 2008, which represents nearly 17-20% of all waste sent to landfill in general waste. The quantity of C&D waste appears to be slowly increasing, amounting to 730,868 tonnes in 2011 and 834,088 tonnes in 2012.

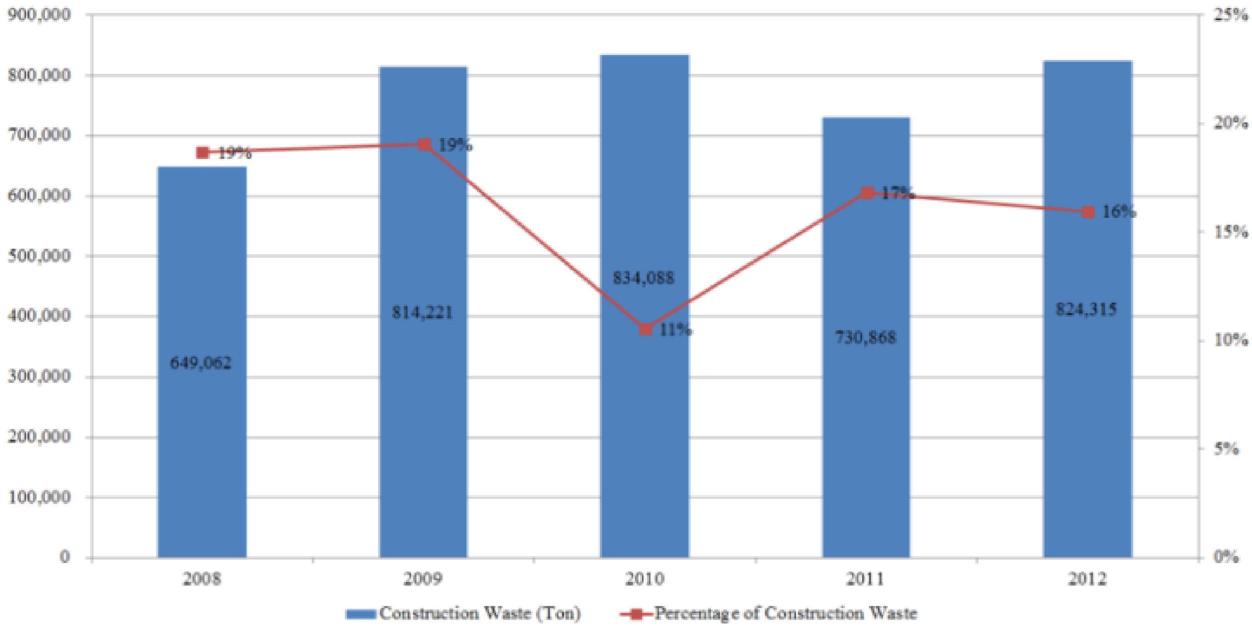


Figure 2-13: Construction waste disposals in South Africa from 2008 to 2012 (Li, 2013)

In MENA it must be pointed out that there is a lack of government oversight and reporting which results in vague estimates of the quantity of C&D waste arising from construction projects and disposed of in public authorised sites or informally. El-Swat (2000) noted that the municipalities in major cities in the Kingdom in Saudi Arabia have no accurate perception of knowledge of the quantity of C&D waste produced. A study conducted by the Arab Urban Development Institute (1986) found that C&D waste is a major burden on hygiene operations in Arab cities, where the increase amounted to 69.4% of the sum total of all types waste in 42 Arab cities. Figure (2.14) shows kinds of waste generation in 42 Arab cities, and the startling conclusion that an estimated 69% of all waste arises from the C&D sector.

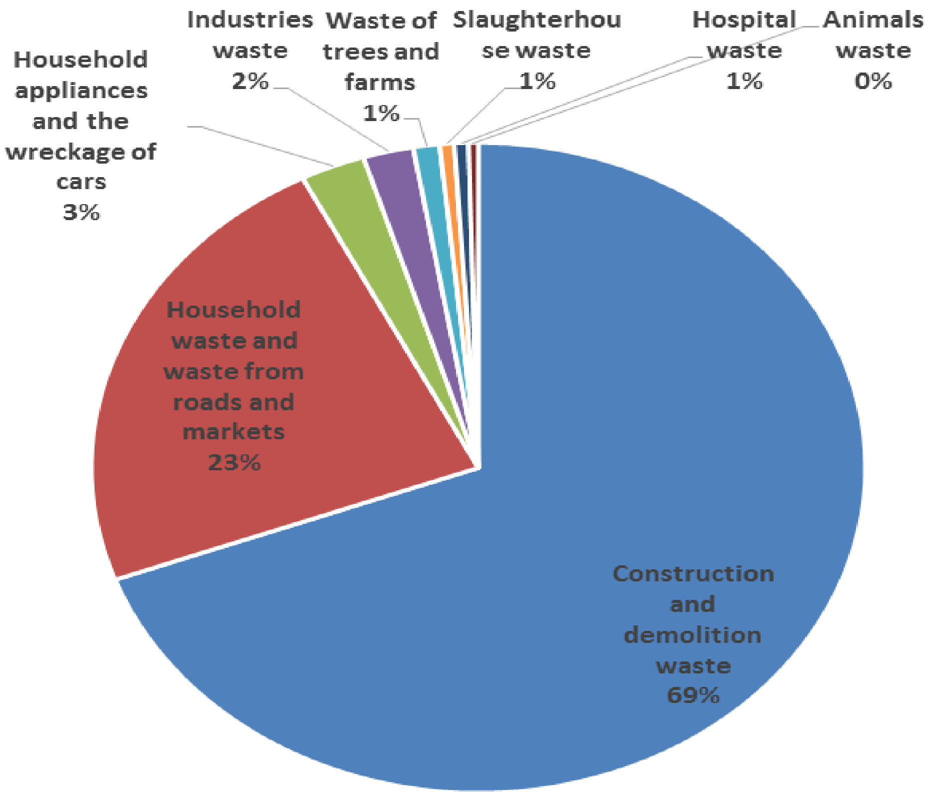


Figure 2-14: Solid waste generation in the Arab cities
(Arab Urban Development Institute, 1986)

Abdasameea (2001) noted there are no precise statistics showing the quantity of C&D waste in the Arab Republic of Egypt, which is notoriously bureaucratic. El Haggar (2000) illustrates that the quantity of C&D waste in Egypt amounts to 10,000 tonnes daily, roughly 4,500,000 tonnes per year, accounting for approximately 33% of all waste produced. Likewise, Mwesigye *et al.* (2009) stated that 4 to 5 Mt of waste is generated by the construction sector in Egypt, comprising only 7% of all waste, which is clearly improbable. In Qatar an estimated 20,000 tonnes of C&D waste is generated every day, of which 50% is recycled per diem to RCA (Al-Ansary, 2013).

In Kuwait, construction waste is 15-30% of all solid waste, of which more than 90% goes to landfills (Kartam *et al.* 2004). Table (2.6) shows the annual statistical approximations of construction waste in Kuwait. In Bahrain the quantity of solid waste generated was about 2,500 tons per day Table (2.7) presents the quantity of waste produced in 2010 (Sector of Human and Environmental Affairs, 2013), from which it can be seen that the highest quantity is waste was generated by construction activities.

Table 2-6: Annual statistical approximate quantity of construction waste in Kuwait received by waste recycling manufacturers and landfill

Year	Quantities of C&D waste recycled (tonnes)	Quantities of C&D waste sent to landfill (tonnes)	Total (tonnes)
2006	997.747	2.808.488	3.801.235
2007	2,673.771	2.648.634	5,322.405
2008	2.686.275	1.735.290	4.421.565
2009	2.231.695	1,375.109	3.606.804
2010	2.500.101	1.665.754	4.165.855
2011	1.183,710	3,118.020	4.301.730

Source: Sector of Human and Environmental Affairs (2013)

Table 2-7: Waste arising in Bahrain in 2010

Type of waste	Quantities per tons
Organic waste	457335.5
Agricultural waste	173128.4
Commercial waste	287511.1
Dead animals	11643.4
Construction waste	528712.5
Industrial waste	87994.7

In Iraq, due to the quick population growth and the country's economic development, massive volumes of C&D waste are generated (Ahmo, 2017). According to the latest statistics from the Central Bureau of Statistics for the year 2010, the annual amount of C&D was nearly 7 Mt, at a rate of 19.1 thousand tons per day. C&D waste represents approximately 39.7 % of total annual solid waste generated in Iraq (Al-Agele and Al-Kaabi, 2016). For instance, Iraq needed to manage in excess of 0.9 million metric huge conflict amount of C&D (Coyne and Pellillo, 2011). This generated waste is mostly dumped in both designated and illegal landfills (Ahmo, 2017). Notwithstanding these negative impacts, there is no framework connected to C&D waste activities in Iraq (Al-Agele and Al-Kaabi, 2016).

According to systems implemented in Iraq regarding both the municipality of Baghdad and those in the Ministry of Municipalities and Public Works, construction materials should be removed from landfill to facilitate reuse and appropriate processing (Ahmo, 2017). The manifest disparity between policy and practice reflects a lack of implementation. Within this grossly inefficient milieu with a lack of substantive enforcement of existing regulation, the Iraqi government has spent approximately $30 billion (US) on cleaning up PC/C&D waste, often with the suspicion of corrupt activities involved (Al-Agele and Al-Kaabi, 2016).

In Syria, a great quantity of C&D waste continues to be generated by the on-going war, estimated to include 142.5 Mt of concrete, 6.65 Mt of steel and plastics, and approximately 0.78 Mt of other kinds of solid waste. Considering these these quantities, it requires a high budget plan to be sent to landfills (Awad *et al.* 2017). According to Madi (2016) and Awad *et al.* (2017), recycling is the main key to decrease negative impacts of environmental pollution as well as providing economic value for waste material.

In the UAE, Abu Dhabi in 2011 generated about 10.69 Mt annually, of which C&D waste comprised 71% of total waste generated, as shown in Figure (2.15). However, this data is not systematic, and relies largely on unaudited records from contractors, thus it cannot be expected to be very dependable (Abu Dhabi Environment Agency, 2013).

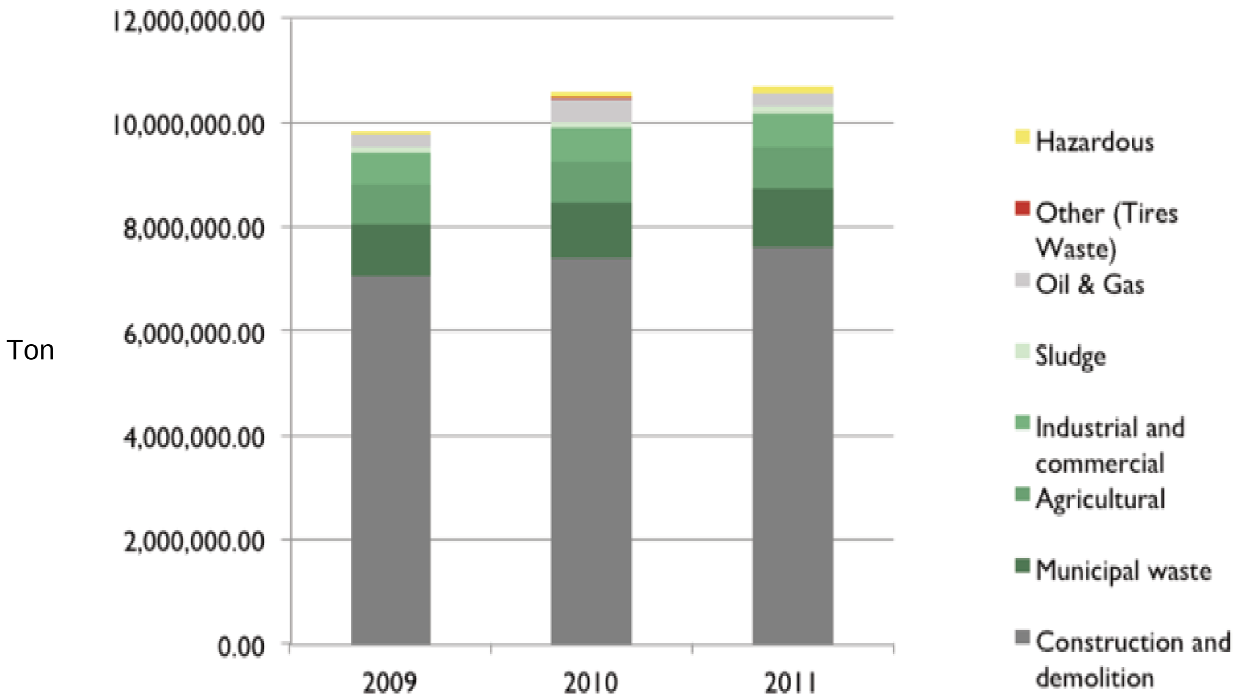


Figure 2-15: Abu Dhabi, total quantity of waste (Abu Dhabi Environment Agency, 2013)

2.10 Sustainable C&D Waste Management (SC&DWM)

The sustainability pattern has come to achieve universal attention since it was initially broached at the UN Conference on Environmental and Development in 1972, through the World Commission on Environment and Development in 1987 and the UN “Earth Summit” in Rio de Janeiro in 1992 (Parkin, 2000). Butlin (1989) defined the idea of sustainable development as ways to improve practices meeting socio-economic development needs without compromising the capability of coming generations. According to Ejohwomu and Oshodi (2014), there was no sufficient evidence of research on sustainability in developing countries compered to developed countries. This calls for shift in paradigm in order to incorporate sustainability into policies and activities of the construction industries in developing countries. Consequently, sustainable construction waste management can be one of area which need to be considered, taking into account three major dimensions, economic efficiency, social satisfaction and environmental efficiency (McDougall *et al.* 2006), as shown in Figure (2.16).

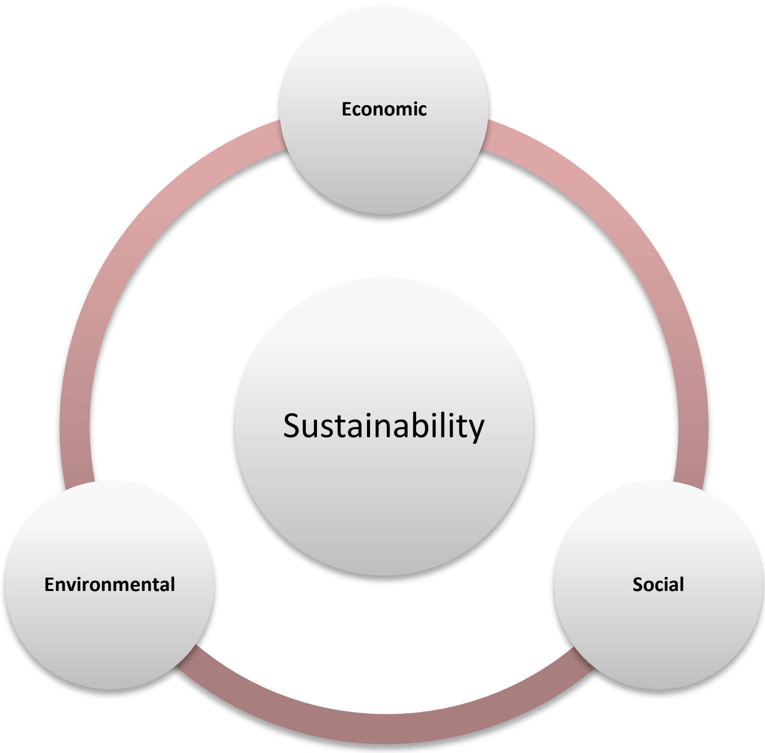


Figure 2-16: The three major elements in sustainable development (Li, 2011)

The construction sector represents massive financial investment, environmental impact, material resources utilisation, occupations creation and waste production (Oyenuga and Bhamidimarri, 2015), and due to numerous macroeconomic factors as discussed previously it became egregiously wasteful from the mid-20th century on wards (Del Rio Merino *et al.* 2010). C&D waste has made harmful effects on the environment such as contamination of soil and water, air pollution, climate change and unfriendly consequences for widely varied vegetation, economy, raw materials, universal notoriety, and impacts on tourism and fuel utilisation in transportation. Figure (2.17) illustrates CO_2 effects of C&D waste based on 2010 data (Defra, 2013), and community wellbeing such as health risks, utilisation of open space, spread of epidemic and effect on safety of working (Spies, 2009; Yeheyis *et al.* 2013). To achieve a low carbon future, the Department for Business, Energy and Industrial Strategy published a *Clean Growth Strategy* that includes funding to support low carbon innovation from 2015 to 2021 and to attain zero avoidable waste by 2050 in the UK (Moore, 2017).

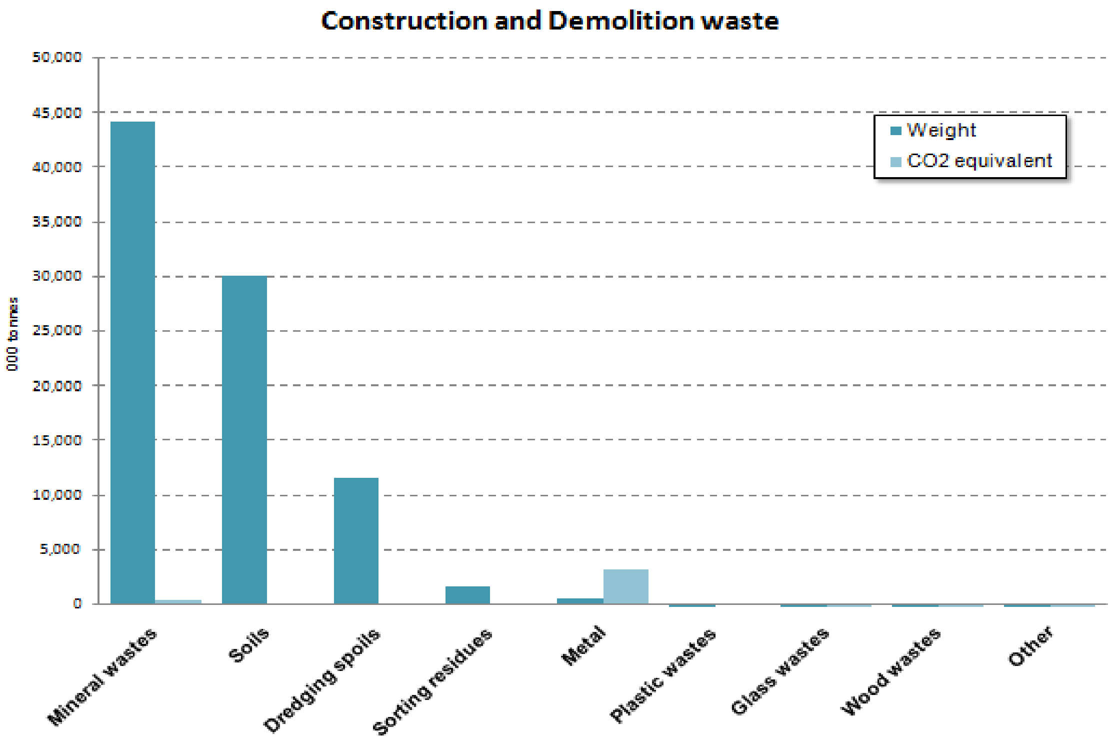


Figure 2-17: Effect of CO_2 for C&D waste types, 2010 (Defra, 2013)

According to Holm (1998), nearly 40% of all materials manufactured are used in the construction sector. The universal consumption of the construction sector accounts for 25% of virgin wood and 40% of gravel and sand every year. For example, according to Woodbridge (1997) Tanzania used about 60 Mt of aggregates in 1997, which equals (2) tons/person/year, with the quantity used in building blocks expected to increase nearly threefold from an estimated 87.4 Mt in 2009 to 219 Mt by 2050 (Population Reference Bureau, 2009; World Business Council for Sustainable Development, 2009), cited by (Sabai, 2013).

Bossink and Brouwers (1996) state that 9% of all substances by weight finish up as waste, and 1-10% of each substance adds to the solid waste flow of the site. Ganesan (2000) pointed out that materials represent the biggest contribution to the construction industry, accounting for 50-60% of total project expenses. Between 90-120 Mt of waste in the UK annually is related to C&D waste, with over 10% of that being classed as unaccustomed materials by official government data (Osmani, 2012; UK Green Building Council, 2013). Therefore. the anticipated profits of the economic and environmental form minimisation of C&D waste are becoming increasingly important business considerations in developed countries (Begum *et al.* 2006; Hunt and Shields, 2014). Consequently, developing a comprehensive policy for C&D waste management will direct the progress of action in the construction industry towards reaching sustainability goals. Figure (2.18) shows several environmental benefits that could be achieved as an outcome of successful construction waste management:

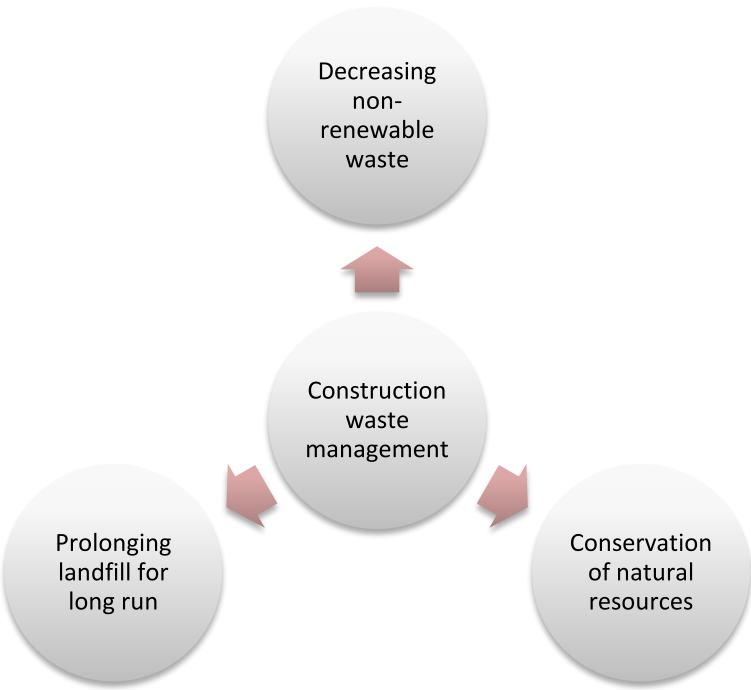


Figure 2-18: Environmental benefits of C&D waste management (Ferguson et al., 1995)

2.11 C&D Waste Management Policy Categorisation and Schemes

A significant number of management theories, methods, approaches and modelling tools can be adopted for C&D waste at various levels (Bani *et al.*, 2009). Tojo *et al.* (2006) investigated eighteen policy instruments in Europe and divided them into three categories: instrument administrative, economic interment and informative instrument. Also, Eunomia *et al.* (2009) cited by Li (2013) distinguished a range of different policy instruments into three categories: command and control instruments, economic instruments and voluntary/negotiated agreements.

Since 1991, the EU has considered C&D waste to be one of six priorities of waste flow because of the enormous quantities of waste produced and their high potential for reuse and recycling (Robles, 2016). For example, the Spanish Ministry of Presidency 2008 has established obligatory procedures (Royal Decree 105/2008) to track C&D waste management, with a view to obtain a fruitful C&D waste management, involving all agents implicated by means of interrelated liability (Robles, 2016). Figure (2.19) illustrate the steps of the C&D waste management model in Spain.

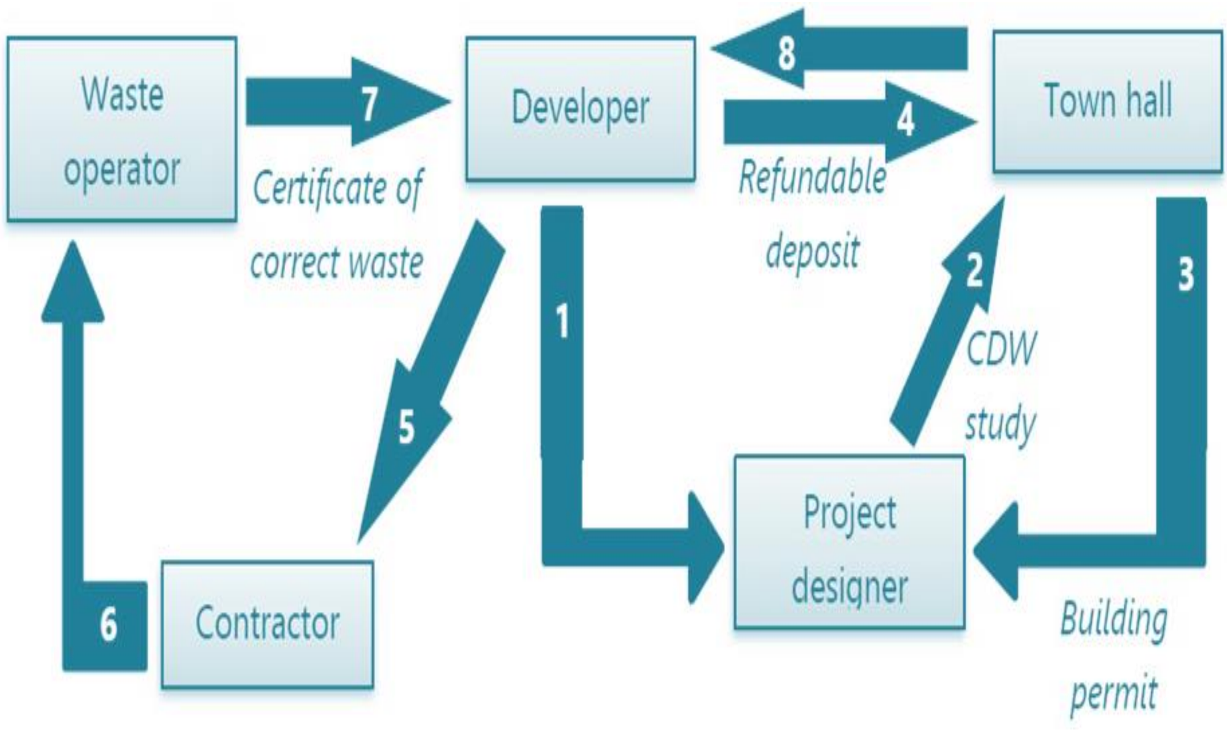


Figure 2-19: C&D waste management model in Spain (Robles, 2016)

In the Netherlands, legislation and regulations were established to ensure that over 80% of C&D waste is either reused or recycled. The main three legislative policies include Landfill Ban, Provincial Environmental Ordinances, and the Building Materials Decree (Dijk *et al.* 2000). Table (2.8) shows such instruments in different countries and regions.

Table 2-8: Summary of waste management policy instruments

	General waste management instrument			C&D waste management instrument	
	Speck and Markovic (2001)	**Tojo *et al.* (2006)**	**Oosterhuis *et al.* (2009)**	**Sonnevera (2006)**	**Eunomia *et al.* (2009)**
1	Taxes and charges Deposit refund systems Tradable permits/liability Enforcement incentive Subsides	Landfill tax; waste disposal tax Deposit refund systems Recycling credit scheme Subsidies for secondary materials Pay as you throw	Waste taxes; Deposit refund systems Subsidies fiscal incentive Tax on raw materials/products Waste collection charges	Landfill tax/ levy/tipping fees Levy on virgin materials	Landfill levy Incentive affecting waste Tax on aggregates
2	Information and educational campaigns Labelling systems Voluntary agreements	Information campaigns to residents Eco-labelling scheme Green shopping guide Mark of products/components Information provision to treatment facilities		Industry government MOU Green procurement Building green programmes	Voluntary agreements
3		Substance restriction Source separation Take-back obligation Collection/reuse/refill/recycling Minimum recycled material content standards Landfill restriction on/diversion Sound treatment standards		Diversion goals Landfill bans Demolition protocol Waste management plan	Minimum recycling standards Product standards Waste facility permit shame Demolition protocol Site waste management plan

1 = economic instruments, 2 = informative instruments, 3 = administrative instruments

Source: Li (2013)

2.12 Waste Policy and Regulatory Framework in the UK

An effective waste management framework has to be sustainable over the long term. It was proposed at the 2001 UN-Habitat World Urban Forum that the neatness of a metropolitan area and the adequacy of its SWM framework might be helpful as intermediary markers of successful preservation of natural resources and prevention of carbon emissions to approach sustainable development (El-Haggar, 2007). Typical waste management as applied in most UK counties is shown in Figure (2.20).

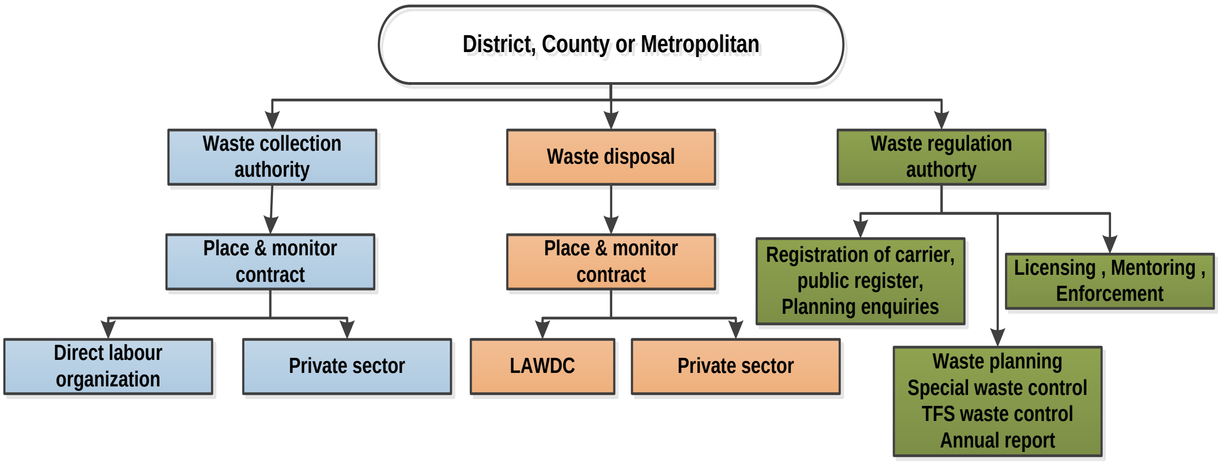


Figure 2-20: Typical waste management in most UK counties (Wan Al-Kadir, 1997)

Significant developments targeted to reduce the negative environmental impacts of C&D waste have been embedded in UK law, alongside initiatives to raise awareness and promote a culture of reducing waste. A combination of regulations, economic tools (e.g. tax policies calibrated to sustainability performance) and voluntary accord to reach ethical, public and environmental performance aims have driven the waste management processes in the UK strategy for sustainable construction (Defra, 2008). Existing regulations to protect human health and the environment from waste hazards may impose substantial burdens on stakeholders, thus it is important that such legislation is proportionate to the danger posed by the processes of waste management and punitive measures against those acting in bad faith contrary to sustainability objectives (Defra, 2013).

Up to 90% of current UK environmental legislation conforms with EU legislation (Jordan, 2006); Germany goes beyond the minimal requirements of the EU and has set itself much stricter requirements to achieve higher recycling rates (Dornac, 2017). Figure (2.21) summarises the UK legislative framework that aims to achieve a 70% reduction by weight of non-hazardous C&D waste (coded as category 170504 in the List of Waste by 2020 (Defra, 2013). The Landfill Tax scheme has been one of the most influential tools according to Adjei *et al.* (2013), along with the Site Waste Management Plan (SWMP) of 2008. However, in some cases there has been pressure on governments to repeal legislation on waste management for commercial interests (Tam, 2008). For example, cost saving was the main reason behind repealing SWMP in the UK (Defra, 2013).

2.13 C&D Waste Management in the UK

As study by Defra (2011) showed that the construction sector is the greatest contributor to the total waste generation in the UK, but the production of waste has gradually decreased, as discussed previously. However, Table (2.9) shows that most developed countries have not achieved such success, and the UK is one of only five of the 11 most economically developed and transfer countries that has taken significant steps to improve waste management (Shi, 2008; Bose, 2010; Ismam, 2014).

Table 2-9: Sustainable development in several countries

Assessment Criteria	Australia	China	UK	USA	Japan	Canada	Singapore	Malaysia	Philippines	Brazil	Indonesia
Management	●	●	●		●				●	●	●
Indoor environment quality	●	●		●	●	●	●	●	●		●
Energy	●	●		●	●	●	●	●		●	●
Transport	●			●	●				●		
Water	●	●		●	●	●	●	●	●		●
Material	●	●	●	●	●	●					●
Land use & ecology	●	●		●							
Emission	●				●						
Innovation	●						●	●			
Sustainable site development				●		●			●	●	
Waste management			●		●		●		●	●	
Preservation of culture context					●				●		
Outdoor environment		●	●	●	●		●	●			●
Occupant comfort			●	●	●						
Procurement			●								
Intelligent buildings				●						●	
Residential building										●	
Application and case study										●	

Source: Ismam (2014)

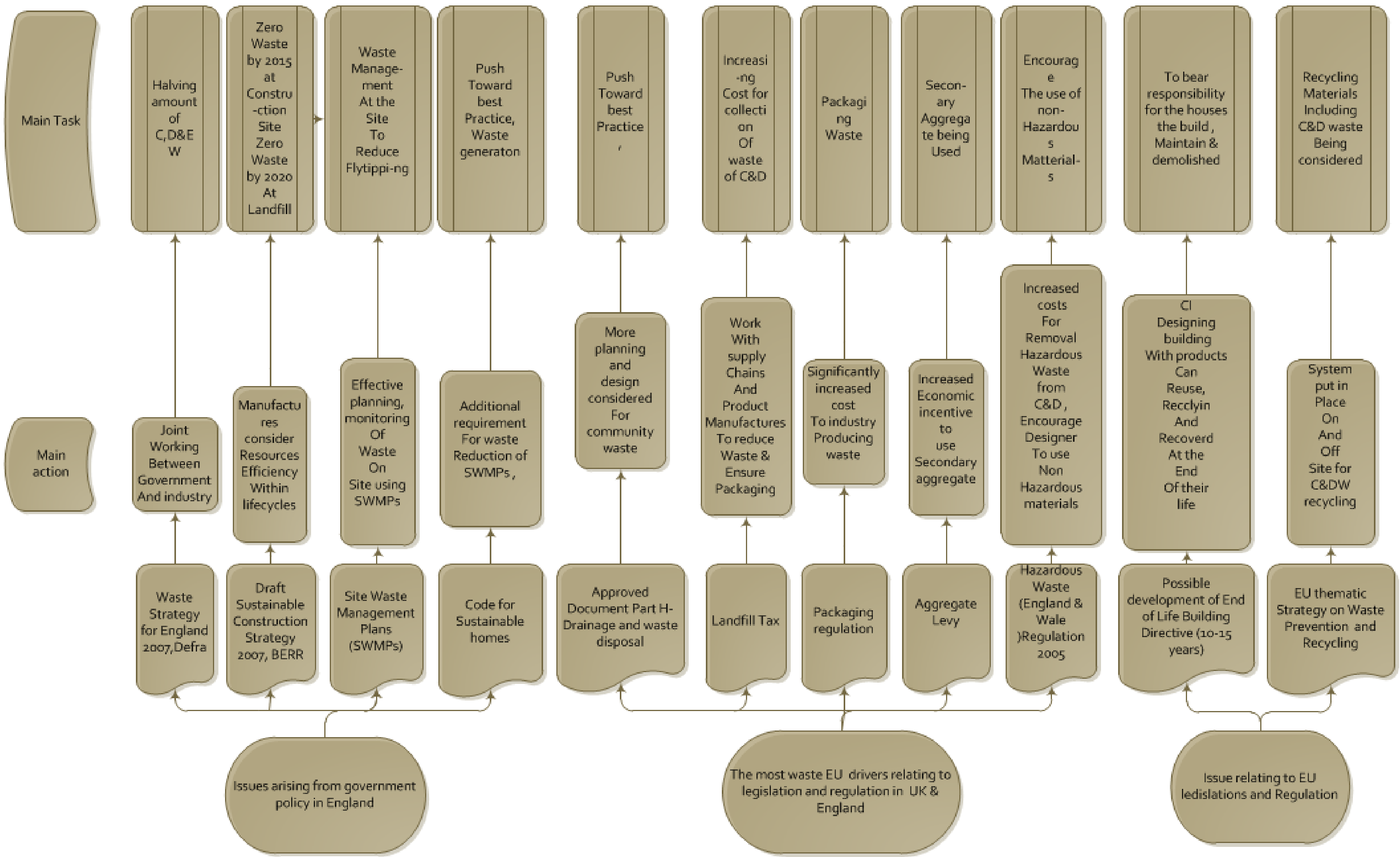


Figure 2-21: Summary of legislation and regulations in the UK

2.14 Best Practices in C&D Waste Management in the UK

A study by Al-Ansary *et al.* (2004) found that one of the major hindrances for reaching sustainable construction aims is the production of massive quantities of building wastes subsequent to C&D works. To support attainment of the UK's waste minimisation goals, several of procedures (regulations and other drivers) have been presented to decrease and manage waste via all phases of C&D activities. There have been major efforts to achieve sustainable tactics to deal with C&D waste by contributing to reduce such waste disposed in landfill to 50% according to the UK against the 2008 baseline (Wrap, 2013).

The revised WFD requires that all EU Member recover at least of 70 % of non-hazardous C&D waste by 2020. The UK is currently achieved this target, or indeed exceeding this target by recovering approximately 89.9% by 2012 (Defra, 2016). According to Aadal (2013), the national aim of Zero waste by 2020 is implemented by a number of economic and administrative regulatory measures, for instance Site Waste Management Plan, BREEAM standard, Landfill Taxes and aggregate levy. Best practice for waste minimisation and management ought to follow the waste hierarchy (Wrap, 2007).

2.14.1 The Waste Hierarchy

Exporters utilise various labels to apprehend the Waste Management Hierarchy (WMH). According to USEPA (1999), the order of WMH is source reduction, recycling, waste combustion and landfilling. Implementing WMH, which was initially introduced in 1975 at the European level (EC, 2015), can be helpful to increase efficiency to reduce waste produced (Wrap, 2007).

According to Defra (2013) applying the WMH reduces the consumption of natural resources and creates economic savings, based on the approved official guidelines for implementation (Defra, 2007; Van Ewijk, 2016). Figure (2.22) shows the principles of WMH and its definitions.

Waste Hierarchy Principles	Definition by Revised WFD
Prevention	Measures taken before a substance, material or product has become waste.
Re-use	Any operation by which products or components that are not waste are used again for the same purpose for which they were conceived.
Recycling	Any recovery operation by which waste materials are reprocessed into products, materials or substance whether for the original or other purposes.
Recovery	Any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy.
Disposal	Any operation which is not recovery even where the operation has as a secondary consequence the reclamation of the substances or energy.

Figure 2-22: Overall waste management Hierarchy
WFD (2008)

The fundamental focus of the Waste Hierarchy is waste being prevented, or reduced, reused and recovered, with arranged disposal being the last choice (Defra, 2011). In practical terms landfill remains the cheapest solution for C&D firms, thus governments are expected to continue incrementally taxing landfill disposal to make this option less attractive (Ashford *et al.* 2000). It should be noted that the Waste Hierarchy is not without its critics, despite being one of the major standards of the waste management in the EU and US (Robles, 2016). Indeed, several Waste Hierarchies have been instituted to minimise construction waste, categorised by Li (2013) as shown in Table (2.10).

Table 2-10: Order of waste hierarchy in different countries

Source	Avoidance	Minimization	Reuse	Recycling	Composting	Energy Recovery	Treatment	Landfill
Denmark		1	2			3		4
European Commission (2006)	1			2		2	3	
European Commission (2008)	1		2	3		4	5	
Hong Kong	1	2		3			4	5
Ireland	1	2	3	4		5		6
South Africa	1		2	3		4	5	6
South Australia	1	2	3	4		5	6	7
United States	1			2		3	4	

Source: Li (2013)

In most countries in which it has been adopted, the WMH follows the same direction of priority for all these countries as shown in the (Table 2.10) (Li, 2013). Table (2.10) illustrates that avoidance and minimisation favoured to reusing excluding US that put the source avoidance and minimisation and reusing at the same level. Reusing is preferred to recycling for all countries/regions. Composting is not regularly implemented in the waste management hierarchy except in the US. Recycling has a higher priority over energy recovery. Table (2.10) also shows that landfill is the least favoured strategy in all the countries.

2.14.2 Proximity Principle

Proximity Principle belief stipulates that waste ought to be discarded as closely as could reasonably be expected to its area of production. It is the most critical waste management strategy in the EU, reflected in major public awareness of the carbon footprint. The UK legislation addresses 'Europe-wide' exertions to reduce carbon outflows out of its building control prerequisite. Thus, in the UK heightened environmental norms have been embedded in a new planning approach and lawful measures (Waddell, 2008).

Regulation 259/93 on the freightage of waste permits EU member states to oppose freightage to other countries of the Union in the event that the freightage is purposed for dumping, but only if the freightage is proposed for recovery (as an alternative). The principle of proximity is instituted by the revised WFD, which necessitates that member states build up an integrated and satisfactory system of "waste disposal installations and of installations for recovery of mixed municipal waste collected from private households" (Defra, 2013).

2.14.3 Duty of Care

The Duty of Care enshrines in law the necessity for all stakeholders to generate, gather, load, store, treat, dump, deal in, broker in and process waste, to control that waste properly by using correct methods of storing and transporting it to the proper people, and guaranteeing that when it is transmitted it is satisfactorily labelled to ensure recovery or disposal without risk to social health or damaging the environment (NIEA, 2014). The Duty of Care enshrines the legal responsibility of all parties to handle waste safely and securely (Defra, 2003).

2.15 Best Practise Drivers in the UK

Waste is the most noticeable appearance of inadequacy in any system. This however relies upon the level of acquiescence to universally acknowledged waste management best practices. According to Husaini *et al.* (2007) a few plans in view of economic, regulatory, legislative and incentive instruments have been utilised as a part of EU to drive an ideal execution. For example, economic drivers which applied as tools relied on weight or value charging plan. In any variation of the plan, the sum paid is commensurate to the quantity of waste discarded. Motivator drivers which designed by domestic authorities to deliver some level of financial or other related to promote waste prevention, for instance, by providing materials to waste producers at supported costs to hearten them to obtain set goal in recycling, recovery etc. (Husaini *et al.* 2007).

In summary, to minimise waste and avoid landfill disposal, the UK has enacted legislation, voluntary codes, market incentives and taxes (Waddell, 2008).

2.15.1 Landfill Tax

The UK Government introduced a tax on landfill on 1st October 1996 to enhance and motivate institutions, particularly in the including construction industry, to cut down the value of waste send to landfill, charging for waste according to different criteria, so that the standard rate of tax will rise by £8 from 2008 until at least 2010/2011 to offer greater financial incentives to businesses to 3R waste (from £24 now to £48 in 2010) (Defra, 2007), and it has further increased dramatically through to the present. The Landfill Tax was introduced for two reasons: (i) to reduce waste disposal, and to motivate waste producers to have steps toward sustainable waste management; (ii) using the money that comes from the tax to cut down employers' National Insurance (Morris *et al.* 1998). However, illegal fly-tipping has increased since the escalation of the Landfill Tax in some countries, resulting in additional punitive measures being brought in against fly-tippers, such as vehicle impoundment (VI), as applied in Israel (Seror *et al.* 2014). According to Rahim *et al.*(2017) increased awareness could be a good solution for reducing fly-tipping in construction activities among construction players. In this regard, the government of Wales will be the first in the UK to establish a new higher rate of landfill disposals tax to prevent people from discarding waste illegally, effective from April 2018 (Moore, 2017). Figure (2.23) shows the material composition of illegal dumping in Malaysia.

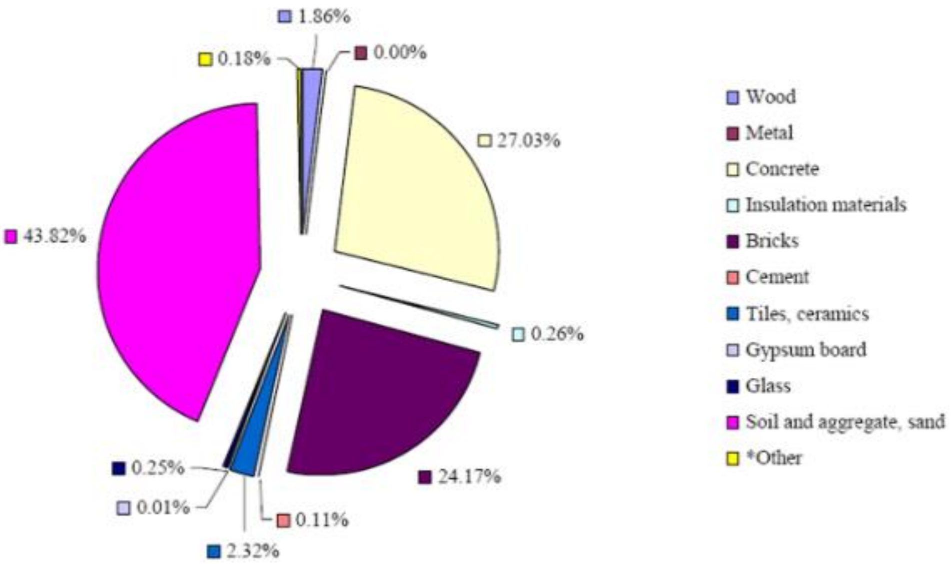


Figure 2-23: Construction waste composition disposed of at illegal dumpsites in Malaysia (Mahayuddin et al, 2008)

2.15.2 Site Waste Management Plan (SWMP)

The Site Waste Management Plan (SWMP) came into force in April 2008, since when it has become mandatory for any project in England worth over £300,000 in the private sector and over £200,000 in the public sector (HM Government, 2008). SWMP cut down the cost of waste sent to landfill reduces hazardous waste and illegal dumping. SWMP regulations are currently aimed only at the public sector in England and Northern Ireland; if the government wants to make a substantial change in waste reduction they should be applied to all construction projects across the UK. SWMP is viewed as one of the imperative components of environmental protection and avoidance of landfill, regardless of project size (Von Meding *et al.* 2013).

However, SWMP 2008 notably neglects consideration of the design stage, whereas more comprehensive approaches confer some responsibility on designers or architects as part of C&D waste reduction (Osmani, 2012). Partly to address this shortcoming, recent regulatory corrections abrogate CDM 2007 with Design and Management Regulation CDM 2015, which incorporates the whole design, construction and administration stages of construction projects across the UK (O'Keeffe, 2015).

2.15.3 Building Research Establishment Environmental Assessment Method (BREEAM)

BREEAM is the world's driving sustainability assessment way for master-planning projects, infrastructure and buildings. It addresses various lifecycle stages, including new construction, refurbishment and demolition. Universally, there are more than 561,000 BREEAM certified developments, and over 2.2 million buildings have been registered for assessment since it was launched in 1990. In terms of waste management, BREEAM encourages sustainable construction activities and reuse where possible, by encouraging suitable design and construction practices to avert materials from landfill. It also seeks to design and modify buildings to have a minimal impact on the climate (BREEAM, 2016). Therefore, a number of C&D waste reduction techniques are currently existing to support contractors to divert waste away from landfill. Building information modeling (BIM) can efficiently tool to minimise C&D waste arising by avoiding design problems, changes, and rework (Lieu *et al.* 2011; Wrap, 2013; Cheng *et al.* 2015).

2.16 Supporting Organisations for Waste Management

2.16.1 DEFRA

Defra is the main state party in UK waste management. Established in 2001, it is in charge of environmental protection, food production and standards, agriculture, fisheries and rural communities, working with some national and international public and private institutions to form and implement policy, including the Waste Implementation Programme (WIP), Waste and Resource Action Programme (WRAP) and the Business Resource Efficiency and Waste (BREW) programme (Defra, 2007).

2.16.2 WRAP

WRAP is a non-profit, state-sponsored institution operating throughout the UK to support organisations such as local authorities, NGOs, community groups and individuals to procure the advantages of decreasing waste and utilising resources efficiently. Flagship projects include Having Waste to Landfill (HW2L), working together with manufacturers and consumers to improve substance utilisation and recycling as much as possible to decrease the volume of materials sent to landfill as well as carbon emissions (Wrap, 2008).

2.17 Best Practise Drivers Transfer from UK to Developing Socio Economic Settings

There is debate about transferring successful practice for C&D waste management in particular from developed to developing countries. Many studies have recommended that effective waste management best practice developed in the western parts of the world could be adopted with adjustment to obtain similar outcomes elsewhere in the developing nations of the world (Barton *et al.* 2008; Matete and Trois, 2008; Van der Gaast *et al.* 2009; UNCTAD, 2014). Barton *et al.* (2008), however, is of the vision that in taking into account waste options which may be appropriate for developing nations, particular options needs to be discounted as a result of particular barriers hindering against their application. For example, an inequality in technological assets and scientific has been found between developed and developing countries. However, proper transferring adoption of a confirmed technology from one place to another can have extremely disillusioning outcomes (Barton *et al.*, 2008). Along these lines, the level of accomplishment in technologies transferred from an advance developed to a less developed nation will rely upon its suitability; sustainability is demonstrated through its effective implementation (Rath and Herbert-Copley, 1993). Many researchers underline these recommendations. For instance, Dunmade (2002) and Madu (1989) expressed that every technology transfer, regardless of whether it is equipment or know-how or both, from one context to another, regularly from developed to developing nations, has its own monetary and social results. Therefore, Wilson *et al.* (2004) emphasises that it is essential for developing countries to plan particular principles in view of their local circumstances. Thus, acknowledging the difficulties inborn in technology transmission from developed to developing nations (UNEP/DTIE/IETC, 1996). Owing to the fact that, many studies linked to C&D waste management are quoted in literature considered to be in developing countries, there are difference in waste production between countries and different construction materials and system, standards, way of practicing and economy (Yahya and Boussabaine, 2006). Given these fundamental differences, it is unattainable to directly transfer results from developed nations to developing nations like Libya.

2.18 C&D Waste Management in Developing Countries and MENA

According to Mahayuddin *et al.* (2008), C&D waste is an increasingly important issue in both developed developing countries due to the sector being sensitive to global macro-economic trends, not least the increasing cost of virgin materials. However, the nature of C&D waste management remains much more national in developing countries (as opposed to the regional framework of the EU). However, in many developing countries more pressing humanitarian and social welfare concerns often divert state funds and attention to immediate disaster relief, with little interest in perceived luxuries such as sustainability in C&D waste management; nevertheless, the need for the latter increases hand-in-hand with socio-economic development (Economic Commission for Africa, 2009; Mwesigye *et al.* 2009). In recent years developing countries have begun to be animated in the direction of better C&D waste management, but they still lack institutions and frameworks to adequately implement such management (Mahayuddin *et al.* 2008). According to Symonds (1999) the common technique for managing C&D waste is to discard it at an informal disposal site, or burn or bury it at the construction site itself.

2.18.1 Current C&D Management Practices in Developing and Transition Countries

In the last 20 years, various SWM ventures have been adopted in developing countries, in a joint effort with external assistance agencies. A few ventures were fruitful in providing permanent effects on the development of SWM in developing countries (Ogawa, 1996). Nonetheless, many ventures proved unsustainable when external assistance agencies suspended their support. Various reasons could be behind that, such as, technical, financial, institutional, economic, and social issues added to the inability to support tasks, which differ from venture to venture. In Brazil, the main directive for C&D waste management was issued by the National Council for the Environment in 2002, to be completely actualised in 2004. However, despite of public and private endeavours to manage and recycle C&D waste in the country, by 2007 less than 5% of C&D waste was recycled in recycling plants (Vázquez, 2013). According to Camgöz Akdağ and Beldek (2017), there are some differences between Turkish and EU regulations, such as the absence in the former of target numbers for excavation soil and C&D waste management regulations. In Malaysia a great quantity of C&D waste is regularly fly-tipped by the wayside, river banks and numerous other open places (Jahi, 2001). Therefore, it is regular for C&D waste to be disposed in MSW landfill. This technique is prevalent in light of the fact that it does not require appropriate arranging or propelled innovation (Kartam, 2004). Also, just 76% of solid waste is successfully collected in country, and just about 5% is recycled, while 95% of collected solid waste is sent to 112 landfills in Malaysia (Papargyropoulou *et al.* 2011). The Malaysian government has issued some strategies to manage C&D waste. For example, according to United Nations Development Programme (2008), in 2005 the National Strategic Plan for Solid Waste Management (NSPSWM) was implemented shaping the foundation for SWM strategy and practice in Malaysia up to 2020. To improve general awareness of sustainability in the construction industry and development in Malaysia, the Green Building Index (GBI) has been introduced as a measure for maintaining international sustainability assessment standards, for example using BREEAM and LEED (Papargyropoulou *et al.* 2011). Figure (2.24) presents timeline of SWM transition in Malaysia.

Figure 2-24: Presents timeline of SWM transition in Malaysia
Source: Saadi and Ismail (2015)

Isman and Ismail (2014) suggested a conceptual framework for vital development of C&D waste management that underlines a few perspectives that the government could utilise in guaranteeing the fruitful application of C&D waste management, as shown in Figure (2.25). It particularly considers regulation, policy, technology and guidelines to guarantee the effective actualisation of the 3R technique.

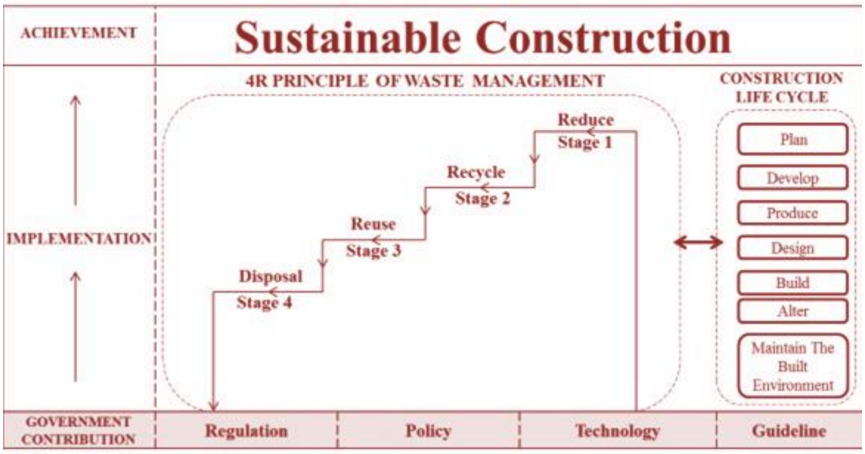


Figure 2-25: Conceptual framework for strategic planning of construction waste management in Malaysia

2.18.2 Current C&D Waste Management Practices in Sub-Saharan Africa

According to Macozoma (2006), some projects in Sub-Saharan Africa have attempted to reuse C&D waste, including low-level recycling applications such as backfilling, site levelling and other landfill purposes, with less use in building and road construction. C&D waste in Sub-Saharan Africa only a few quntities are reported in the authorised landfill site (Macozoma, 2006). In Tanzania, C&D waste is viewed as waste to be thrown into landfill sites or dumped somewhere else, despite the many possibilities of recycling (Hansen, 1992; EC, 2000; Masood *et al.* 2002). In Tanzania, recycling and understanding how C&D waste can be recycled, particularly to worthwhile products such as construction substances, remains limited (Sabai, 2013). C&D waste is still categorised as part of MSW and sent to disposal sites rather than reused or recycled (URT, 2003, 2004). In Nigeria, despite government attempts to reduce construction waste diverse approach and technique should be implemented to achieve efficient management (Baba and Suratkon, 2017).

2.18.3 Current C&D Waste Management Practices in MENA

In MENA, the production of solid waste has come to be an increasingly significant environmental matter in the last ten years, owing to the significant increase in inhabitants and the alteration of ways of living, associated with massive increases in waste generation (EL Mabrouk, 2009). Waste management issues are now prioritised by many MENA countries seeking appropriate solutions (Nassou, 2016). According to Kabir *et al.* (2013), many Arab countries have tried to sort out SWM with the application of a number of regulations and laws. However, there is lack of statutory standards and functioning governmental structures to deal with enforcement. Also, most states in MENA have not issued appropriate waste legislation and long-term policies.

Waste management in MENA countries is distinguished by: (i) centralisation of power at the national level; (ii) lack of functional cost restoration systems; (iii) shortfall of trained personnel; (iv) service imbalance amongst rustic and urban zones; and (v) absence of dependable databases. Waste is the most important environmental problem facing the construction industry at this time. The problems identified from a UK report on the seriousness of fly tipping of C&D waste (Ferguson, 1994) are multiplied manifold in most countries in MENA, where fly tipping (i.e. dumping waste in desert areas) is essentially the main method of disposing of waste (El Mabrouk, 2009). For instance, in Erbil region landfilling is the common practice adopted for C&D waste management due to the lack of some factors as tax on landfilling (Maruf, 2017). Table (2.11) presents waste management practices in some cities and countries in MENA.

Table 2-11: Waste management practices in MENA areas:

City	Landfilling	Incineration	Composition	Recycling
Aden	Y	N	N	P
Aleppo	Y	N	N	P
Amman	Y	P	N	P
Bahrain	Y	P	N	P
Cairo	Y	P	P	P
Kuwait	Y	P	P	P
Riyadh	Y	P	P	P
Tunis	Y	N	p	P

Y: yes N: No and P: Partly use.
Source: EL Mabrouk (2009)

Egypt and Abu Dhabi have thus far pioneered the identification of fly tipping C&D waste as a problem and an antisocial behaviour, but awareness and enforcement of existing legislation remains low (Abo Sena, 2004; Abu Dhabi Environment Agency, 2013).

In Egypt a general ban on discarding C&D at unauthorised sites in Law 38/1967 and Law 4/1994 is reinforced by Law 140/1956 that precisely bans the disposal of C&D in public places. Law 38/1967 likewise requires private landlords to retain their properties free of amassed C&D waste. Supplementary laws have requirements that manage the storing and transportation of waste as a rule, particularly C&D waste. Laws No. 106/1976 and No. 101/1996 permit domestic governments to comprise the C&D waste management via the permits wanted for construction works. This law additionally permits domestic governments to gather a charge from contractors and proprietors to, in addition to other things, give or pay for C&D waste gathering as well as transfer.

In Saudi Arabia many waste recycling plants were constructed recently, but they failed due to poor operation, construction or technological procedures (Kabir *et al.* 2013). The owner of construction projects is obliged to transfer C&D waste to designated sites or authorised companies for waste management in Jeddah, but the local municipal authorities do not maintain appropriate capacity for disposal sites, thus most waste ultimately sent to landfill (Nassour *et al.*, 2016; Ouda *et al.*, 2017). Additionally, there is no implementation by legislation to handle waste before discarding of it; extraordinary waste situations require distinctive arrangements, which is why the state and other stakeholders should know about the different ways accessible for waste control (Albawaba, 2009). According to Ouda *et al.*(2017) to achieve SC&DWM, it is basic to underline the different elements that may hinder the development of C&D waste management practices in the Kingdom of Saudi Arabia. While the government often legislates for environmental protection in MENA, there is a disconnect between the regulatory ideal and the reality at the municipal and industrial level of implementation (Kabir *et al.* 2013).

A relatively more successful case is offered by Kuwait, where up to 2,500 tons of C&D waste is generated per day. Proprietors of construction ventures are obliged to transfer their waste to the Environmental Protection and Industrial Co., essentially a public-private organisation which assists in enforcement for the disposal of materials such as aggregate (Kabir *et al.* 2013).

Abu Dhabi has gone further than most regarding waste management in the last decade, applying an efficient waste collection scheme for MSW and cleaning open ranges, with modernistic equipment and frameworks, and closer management of contractors. Waste management must be consistent with Federal Law No. 24 of 1999, Domestic Law No. 16 of 2005 and Domestic Law No. 21 of 2005, with responsibilities accrued by the Environment Agency of Abu Dhabi (EAD), the Centre for Waste Management of Abu Dhabi (CWM) and the Department of Municipal Affairs (DMA) (Abu Dhabi Environment Agency, 2013).

The Masdar project aims to make Abu Dhabi the first sustainable city in the world, recycling 98% of construction waste every day (Kabir *et al.* 2013). Nonetheless, according to Abu Dhabi Environment Agency (2013) there is a lack in management capacity and order of C&D waste in Abu Dhabi, as shown in Table (2.12), which may affect the target of diverting 90% of C&D waste from landfill in 2018.

Table 2-12: Construction and demolition waste management

Waste flow	Current infrastructures	Gaps
Construction and Demolition (C&D) waste	Two C&D waste recycling facilities with capacity of 10,000 tonnes per day	-Spoilt loads of C&D due to contamination, and illegal dumping. -Shortage in demand for recycled aggregates

Source: Abu Dhabi Environment Agency (2013)

2.19 Barriers and Challenges to SC&DWM

There are different barriers and challenges inhibiting the implementation of C&D waste management in different phases of construction. One of the greatest significant issues in the recycling C&D waste is the availability (or obtainability) of facilities to receive production (Mills *et al.* 1999). For example, in Vietnam only one plant is working and eligible to reprocess 40 tonnes of concrete waste per hour (Kien *et al.* 2013). The UAE has a generally adequate infrastructure, but the increasing scale of construction activities are an economic and physical barrier to sustainable practices (Al-Hajj and Hamani, 2011). According to Adewole (2009) the main latent barriers to sustainable waste management are increasing population, waste dumping practices, labour attitudes and corruption.

Yuan *et al.* (2011) state that C&D waste management can be impacted by various barriers such as: a shortage of acceptability of secondary materials, the expense of application of waste management, supplementary time to conduct design waste assessment, a few or no monetary motivations, shortage in government policies and law enfacement, shortage of information about waste sources, absence of training on the way of application waste management and the conviction of the construction industry that C&D waste inevitable consequence.

Likewise, Yuan *et al.* (2011) and Sibanda *et al.* (2017) stated that the greatest hindrances to applying C&D waste management can be separated into five groups: inadequate regulation, absence of waste recycling shop, inadequate awareness concerning C&D waste management, insufficient economic motivation, and lack of workers' skills. To achieve a comprehensive understanding of barriers that may hinder the process of SC&DWM in developed countries, Table (2.13) presents the main barriers for C&D waste management in Spain.

Table 2-13: Main barriers to C&D waste management in Spain

Kind of barrier	Clarification
Political barriers	-Non reliability data recovery and recycling rate of C&D waste in EU and manner of collection -Lack of control over C&D waste management plan approval by national and regional government
Social barriers	-Lack of coordination between the agents involved in C&D waste management -No initiatives to launch information and awareness programme for agents involved in sector -Lack of enforcement and unclear responsibility 3Rs regulation
Economic barriers	-Constructors usually do not include specific allocation for C&D waste management -Constructor do not facilitate waste management plans by including them in the technical specification -Constructors do not currently fulfil their obligations as producers of hazardous waste due to the high cost of managing C&D waste and the imprecision of current legislation
Technical barriers	-Constructors do not make provision for use of recycling materials -Technical standards do not make provision for use of recycling materials -No EU legislation to regulate installations for the treatment of C&D waste

Source: Calvo *et al.* (2014)

Agamuthu (2008) pointed out that the challenges prevent SC&DWM: (i) deficiency of clear legislature controlling C&D waste which is specially regular in developing countries; (ii) lack of enforcement of legislation and regulations concerning fly tipping of C&D waste (which is much more prevalent in developing countries); (iii) contingency C&D waste management; (iv) considering C&D waste as part of MSW; (v) C&D waste production rate is generally much higher in developing countries.

Lockreya *et al.* (2016) concluded that nowadays C&D waste practice in Vietnam is unsuitable for C&D waste classification. They stated that this was due to the lack of control of the waste stream by private companies due to low competence or cost-saving policies utilised by public and private interests, with an impasse in the current waste transport and the absence of consideration given to recycling concrete waste, all in the context of an absence of effective laws and financial support from the government for the construction industry.

According to Huang *et al.* (2018) the main barriers to reduce C&D waste are lack of building design standards for reducing C&D waste, low cost of discarding C&D waste, and unsuitable urban planning.

According to Yuan (2013a), an important barrier towards SC&DWM is the lack of knowledge among designers (e.g. architects) about the causes and process of waste production during a project. Therefore, it is substantial to consider the existing information grade of architects and the possible effect of a lack of awareness they may have about the issue (Osmani *et al.* 2008). Liu *et al.* (2018) states that with lack of relevant policies, laws and regulations - adopting the BIM is the best measure, which can successfully reduce the generation of architectural waste products, strengthens the efforts of supervision and delivers tax-redemption and subsidiaries. It also enhances the recycling and reusing of several construction wastes. Some other barriers identified by a review undertaken by Ghoddousi *et al.* (2015) are shown in Table (2.14).

Table 2-14: Barriers and challenges against implementing SC&DWM

Barriers	Source
Absence of regulations and building codes to mandate C&D waste management	(Ling and Nguyen, 2013)
Absence of support from key stakeholders	(Ling and Nguyen, 2013)
Absence of incentives from construction regulatory authorities; low costs of sending materials to landfill	(Ling and Nguyen, 2013)
Lack of budget in construction projects for managing waste	(Ling and Nguyen, 2013).
Absence of contractor awareness and culture regarding about waste management	(Poon, 2007)
Absence of community attention on C&D waste management	(Teo and Loosemore, 2001)
Low prices of building materials	(Poon, 2007)
Absence of economically-viable facilities for-waste management	(Sassi, 2008)

Source: Ghoddousi *et al.* (2015)

According to (Ghoddousi *et al.* 2015) the main barrier to sustainable C&D waste management in Iran is lack of attention to waste management in current regulations. Generally, an absence of human resources (HR) at both the national and local levels with the specialised abilities important for waste management, such as arranging and operating responsible practices, is a common barrier in developing countries (Ogawa, 1996; Mahayuddin *et al.* 2008). Table (2.15) summarises the major barriers facing ISWM in the MENA.

Table 2-15: Barriers facing ISWM in MENA`

City Difficulty	Aden	Amman	Bahrain	Cairo	Kuwait	Riyadh	Tripoli	Tunis
Scarcity and conflict of information and record	Y	Y	Y	Y	Y	Y	Y	Y
Diversity of operating agencies	N	N	N	Y	N	N	N	Y
Lack & inefficient equipment	Y	N	N	Y	N	N	Y	Y
Lack of finance	Y	Y	N	Y	N	N	Y	N
Lack of legislation and planning	Y	Y	Y	Y	Y	Y	Y	N
Lack of technical staff and labour	Y	Y	Y	Y	Y	Y	Y	Y
Lack of training and capacity building	Y	Y	Y	Y	Y	Y	Y	Y
Inefficient management processes	Y	Y	Y	Y	Y	Y	Y	Y
Lack of public awareness and involvement	Y	Y	Y	Y	Y	Y	Y	Y

Y: yes- the difficulty exist: N: No - the difficulty does not exist
Source: EL Mabrouk (2009)

Among these various studies there seems to be a consensus on a number obstacles that may face successful C&D waste management. This is demonstrated in Figure (2.26), which summarises the major barriers that could face developing countries in terms of C&D waste management.

Figure 2-26: Barriers to SC&DWM in developing countries

2.20 Summary

Despite the immense economic, health and environmental importance of C&D waste management, it has remained one of the most egregious failures of sustainability efforts, especially in developing countries. The literature discussions in this chapters established that C&D waste practices in the UK and developed countries are more sustainable compared with those in developing countries. Poor performance and a lack of legislation is the norm, despite a considerable number of strategies and instruments that can be adopted for managing C&D waste at various levels. The enforcement of a clear legislative approach and efficient financial strategies (e.g. Landfill Tax), might be the driver of sustainable C&D waste management practices.

This chapter reviewed C&D waste arising globally, in the UK, MENA and developing countries, as well as the sources, composition and characterisation of C&D waste, showing the sources C&D waste in pre-construction, during construction and in post-construction and demolition stages. In this chapter, barriers hindering the process of adopting SC&DWM have been reviewed, showing that there is similarity in some barriers between developed and developing countries.

The importance of estimating the quantity of C&D waste arising for efficient waste management and methods of estimation have also been reviewed. Since it is unattainable to straightforwardly transfer results from developed countries to developing countries like Libya, we cannot just rely on existing knowledge. Therefore, to obtain a systematic enquiry, it is fundamental that the concept of SC&DWM be first understood from previous literature. Aside from addressing this, the following chapter reviews current SWM in Libya.

3 OVERVIEW OF SOLID WASTE MANAGEMENT IN LIBYA

3.1 Introduction

This chapter presents the current situation of SWM in Libya as background knowledge, exploring two main themes: the general background information of Libya's geography, socio-demographic factors and economy (with a brief overview of the construction sector); and the institutional framework pertaining to waste management (i.e. ministries and other institutions involved).

3.2 Country Background

3.2.1 Location and Broader Geography

Libya is located in the centre of North Africa and comprises the third-largest country in Africa by land mass, with a total land area of 1.757 million km^2. The country is bounded by the Mediterranean Sea in the North, Egypt in the East, the Republic of Sudan in the South-East, Chad and Niger in the South, Algeria in the South-West and Tunisia in the North-West, as shown in Figure (3.1). Libya is divided into three states, Tripolitania, Cyrenaica and Fezzan, which enjoyed federal status from independence in 1951 until 1963, when the country became a unitary state.

Figure 3-1: Libyan map and location
Source: National Geographic (2009)

3.2.2 Population

Libya's official population is about 6,411,776, growing at an estimated 4.85% per year according to an estimate in 2013 (CIA, 2016). Table (3.1) demonstrate Libyan demographic and socio-economic indicators. Almost 85% of Libyans live in the coastal area, particularly in big cities like Tripoli (the capital), Benghazi, Misrata and so on. The residual 15% are in the southern desert in cities and towns like Sabha. The net population density of Libya is extremely low, at around two people per km^2 (European Environment Agency, 2015).

Table 3-1: Libyan demographic and socio-economic indicators

Population	6,411,776 (July 2015 estimate)
Population growth rate	2.23% (2015 estimate)
Birth rate	18.03 births/1,000 population (2015 estimate)
Death rate	3.58 deaths/1,000 population (2015 estimate)
Major urban areas - population	Tripoli (capital) 1.126 million (2015)
Life expectancy at birth	Total 76.26 years Male: 74.54 years Female: 78.06 years (2015 estimate)
Infant mortality rate	Total: 11.48 deaths/1,000 live births Male: 12.42 deaths/1,000 live births Female: 10.5 deaths/1,000 live births (2015 estimate)
Urbanisation	Urban population: 78.6% of total population (2015) Rate of urbanisation: 1.13% annual rate of change (2010-15 estimate)
Hospital bed density	3.7 beds/1,000 population (2012)
Literacy rate	Total population: 91% Male: 96.7% Female: 85.6% (2015 estimate)
Contraceptive prevalence rate	41.9% (2007)
Unemployment, youth ages 15-24	Total: 48.7% Male: 40.8% Female: 67.8% (2012 estimate)
Industrial production growth rate	-13% (2015 estimate)
Labour force	1.195 million (2015 estimate)
GDP - per capita (PPP):	$15,100 (2015 estimate) $16,000 (2014 estimate) $21,100 (2013 estimate)

Adopted from: Central Intelligence Agency (2016)

3.2.3 Economy

The World Bank classifies Libya as an upper-middle-income developing country, totally dependent on the oil and gas industries, which make it potentially one of the richest countries of Africa (Abaydar and Laytimi, 2005). However, decades of stagnation and international sanctions, and the on-going conflict since 2011, have paralysed the country's economy (Chivvis and Martini, 2014).

3.2.3.1 Construction Sector

Between 1980s and 1990s, as a more stringent economic atmosphere prevailed due to decrease in universal oil costs, the government acquainted an arrangement of loans with individual Libyan natives in light of monthly deductions at affordable levels based on employees' salaries. Table (3.2) shows a valuable overview of loans made by savings and real estate investment banks to both construction projects and Libyan individuals' between1966–2005. Self-sponsoring housing construction projects between 1970 -1996 are approximately 80329 units (Otman and Karlberg, 2007). According to Noozz (2012) reconstruction process were estimated after conflict in Libya costs totalling $480bn (US), Libya's infrastructure and construction sector is fast becoming one of the most active in the MENA region.

Table 3-2: Loans made by savings and real estate investment banks to both construction projects and Libyan individuals

Year	Loans for housing	Construction projects	Total	Year	Loans for housing	Construction projects	Total
1966	6.0	-	6.0	1986	7.9	07	6.6
1967	5.0	-	5.0	1987	11.8	0.5	12.3
1968	3.5	-	3.5	1988	20.3	0.4	20.7
1969	4.8	-	4.8	1989	13.6	3.2	16.8
1970	10.1	-	10.1	1990	26.4	3.3	29.7
1971	16.4	-	16.4	1991	30.0	2.5	32.5
1972	22.3	-	22.3	1992	8.6	1.3	9.9
1973	15.5	15.4	30.9	1993	12.4	1.3	13.7
1974	36.6	15.0	51.6	1994	19.0	1.4	20.4
1975	13.6	1.4	15.0	1995	18.0	1.8	19.8
1976	3.7	0.8	4.5	1996	18.6	2.4	21.0
1977	55.3	0.2	55.5	1997	31.6	4.7	36.3
1978	35.9	-	35.9	1998	17.2	20.2	37.4
1979	8.3	-	8.3	1999	9.9	25.5	35.3
1980	40.4	-	40.4	2000	37.7	17.0	54.7
1981	61.9	-	61.9	2001	75.	18.7	94.2
1982	78.7	4.2	82.9	2002	302.9	12.6	315.5
1983	39.6	0.6	40.2	2003	511.6	198.6	710.2
1984	53.6	1.4	55.0	2004	886.0	83.8	969.8
1985	7.2	0.2	7.4	2005	1554.0	84.0	1638.0

In Million Libyan Dinar, Source: Otman and Karlberg (2007)

3.3 Overview of C&D and SWM in Libya

In recent years, a developing concern has created amongst the populace about the insufficiencies of SWM in country (El-Trerike, 2001). Studies have been undertaken in the field of SWM, generally on MSW, and their findings cannot be generalised beyond this scope. In addition, there is no study focused on C&D waste management, except a few studies on the potential of using C&D waste as an aggregate for concrete work or sub-road materials. A number of related studies are reviewed below.

According to Faras and Al-Kario (2004), the beginning of integrated municipal facilities for hygiene followed the beginning of large-scale oil exploitation from the 1960s onwards. Consequently, laws and legislation were issued to manage these facilities. Henry *et al.* (2006); Ulubeyli *et al. (*2017) noted developing countries, particularly in Africa, are still reliant on traditional rudimentary methods of managing solid waste (e.g. landfill and open dumping), including Libya (Eltriki, 2013). This is generally attributable to the absence of legislation and appropriate enforcement, although numerous other factors are involved in the inefficiencies of SWM (Saleh, 2005; Eltriki, 2013; Gebril, 2013).

The current framework of SWM in Libya is affected by economic, institutional, authoritative, specialised and operational requirements. The procedure of collection is inadequate regarding labour and vehicle availability. For example, the waste tipping accumulation after collection into an open area at Ganfoudah site near Bangazi remains totally untreated. The absence of appropriate facilities and deficient management and technical abilities, inappropriate container collection and path arranging are among the issues bringing about poor collection and transportation of MSW (Gebril, 2010; Omran *et al.* 2011). Furthermore, there is a lack of data on daily solid waste production in Libya and no legitimate records on the quantity or composition of waste generation in the entire nation (Saleh, 2005).

Eltriki (2013) during his Ph.D. study focused broadly on the structure and connections between different state offices saddled with solid waste administration obligation and highlights significant obstructions militating against their endeavours for the reasonable administration of solid waste in Libya. With regard to C&D waste in particular, Elazhari *et al.* (2013) and Alatshan *et al.* (2015) speculatively noted its potential benefits in terms of recycling. Since the beginning of interest in solid waste facilities Libya has drafted laws and regulations, the most important of which related to waste management are shown in Table (3.3).

Table 3-3: The most important articles in the laws of waste and environment management in Libya

Low No. (15) in 2003	Law No. (13) in 1984	Health Law No. 106 of 1973
Article 14 prevents the incineration of oil, rubber materials and garbage, as well as other organic materials for disposal, in populated areas or nearby. Article 55 prohibits the use of public forests as areas of the execution of the oil, chemical and rubber waste and garbage and construction waste, civil works or throwing scraps, dead animals or their parts. Chapter 10 concerns sanctions and Article 73 specifies fines of not less than five hundred dinars and not exceeding a thousand dinars for each case of construction waste or oil or chemicals or garbage or scrap or dead animals or their parts in the forests, parks and streets and public squares and other public places. Executive regulations of the law stated in Article 11 prohibit the authorities and people from disposal of solid, liquid or gaseous waste and garbage in non-designated areas. Prohibits the dumping of garbage waste and construction waste, chemicals, scrap and dead animals or their parts in front of houses and administrative buildings or on the streets, plazas and parks and the beaches of the sea and the forests and public parks and other places open to the public.	Article (1) in Chapter 1 (general provisions) prohibits individuals, organisations, corporations, companies, establishments and institutions, whether public or private, national or international, from disposing of household waste and garbage, building waste materials, chemicals and scrap metal in non-authorised places. Chapter 2 deals with collection and preservation and garbage and the responsibilities of each party, including household members' responsibility for preserving waste in special containers until collection or removal to assembly containers. Obligations of industrial and chemical establishments, hospitals, research centres etc. to dispose of hazardous waste by appropriate technical means, by approval of competent authorities. Such waste shall not be dumped or disposed of among household waste and garbage (Article 11). Chapter 3 defines collection use, in terms of quality and operation. Chapter 4 defines waste Chapter 5 defines procedures related to street, squares and vacant cleaning Chapter 6 deals with necessary procedures for buildings, cleaning, maintenance and painting Chapter 7 deals with markets, and agricultural and animal production market square cleaning Chapter 8 is concerned with waste disposal under the terms required for dump areas (Article 43) Article (44) provides for strict compliance to dumping terms, in relation to the disposal of solid waste Article (45) defends the possibility of transforming waste into metal, plastic and glass material, to be deposited for towns inhabited by more than 50,000 populations.	Waste collection and disposal Article (322) Municipalities are responsible for waste collection and transference to allocated places; can be subcontracted according to conditions and specifications. Article (323) Municipalities provide administrative and technical staff to oversee the implementation and follow-up workflow in public facilities. Article (324) Municipalities determine the detailed specifications of how to store waste until collection. Article (325) Municipalities provide baskets in the streets, plazas and markets for waste disposal and to prevent ditching in unallocated places Article (326) Determines the dates and time of waste collection Article (326) Determines transfer collection sites Article (332) Determines the maximum licenses granted for waste collection Article (333) waste collection can be by licensed organisations and firms. Article (337) Prevents waste transfer by non-allocated means. Article (340) Sorting waste should be in allocated places Article (343) Location and specifications of landfill sites

3.4 Sequence of Laws and Legislation on Waste and Environmental Management

According to Etriki (2013), since 1976 a bundle of laws and legislation concerning MSWM has been issued in Libya. By and large, the laws have been detailed to define municipal duties regarding waste management and the components through which the Ministry of Housing and Public Utility (MHPU) can encourage the financing of waste management offices and raising funds for waste management operations.

Law No. (5) of 1969 on the planning and organisation of towns villages, as amended, noted the under-reporting of rules and principles of planning contributes to protect the environment from pollution, particularly part 5, which stated the provisions relating to the establishment, management and maintenance of public utilities such as water and sewage. Law No. (130) of 1973 addressed the local administration system, bringing services closer to the citizens and involving them in the management of local facilities related to the affairs of their lives within the framework of a decentralised system. However, decentralisation to provincial governments led to municipalities issuing uncoordinated regulations that generally ignore the environmental dimension and pollution.

Law No. (39) of 1975 was issued to organise the Ministry of Municipalities, which includes in article 2 the structure of the Ministry, including the General Administration of Environment Protection, which is concerned with actual supervision of all matters related to drinking water in terms of compliance with health requirements and following healthy, modern waste disposal methods. It also gives detailed terms of reference for environmental protection from pollution and preventive measures in collaboration with the Ministry of Health and other agencies to prevent pollution and to preserve public health.

The decision of the Minister of Municipalities No. (94) of 1976 identifies duties of garbage collection for occupiers of houses, shops and factories and other places with a view to maintaining public hygiene. Decision (81) of 1976 issued by the Ministry of Municipalities for the regulation the water and sewage facilities as well as management and maintenance the public utilities outlines fees and requirements pertaining to violations. Decision (142) of 1976 indicates additional ways of waste disposal in accordance with rules and health regulations as well as the way of operation of landfills.

Law No. 15 of 2003 is the essential modern legislation for protection the environment, accommodating management of environment issues pertaining to air, soil and water, although it does not explicitly deal with MSWM. There are also some articles on public health, reviewing Law No. 7 of 1982, indicating the belated but existent grappling with waste and environment management issues by the former regime. Indeed, Libya was one of the first Arab states to establish dedicated environmental legislation, and it joined numerous international conventions to improve environmental protection and waste management, as shown in Table (3.4).

However, the implementation always lags behind the vision (European Environment Agency, 2015), as in most developing countries (Deutz and Frostick, 2009). The government is now identifying gaps and examining current legislation to bring environmental policies in line with European norms (European Environment Agency, 2015).

Table 3-4: Environment conventions ratified by the Libyan Authority

Convention	Date of ratification	Reporting obligation
The Ramsar Convention on the Preservation of Wetlands	1971	Information Sheet on Ramsar Wetlands (RIS)
The Convention on Biological Diversity	1992	National report on implementation of the Convention
The Cartagena Protocol on Biosafety	2000	National report
The Convention on International Trade in Endangered Species of Wild Fauna and Flora.	1973	Annual report on CITES trade and biannual report on legislation
The Vienna Convention and Montreal Protocol to Protect the Ozone Layer	2014	Annual ODS report
The Basel Convention on the Control of Hazardous wastes and their Transfer Across Borders	1989	Yearly report to the Convention
The United Nations Convention to Combat Desertification	1995	Report on implementation
Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous wastes within Africa	1991	Report on implementation

Source: European Environment Agency (2015)

Therefore, in order to achieve the study aim, it was important to review and be aware of all the laws and regulations issued regarding the environment and waste management over the previous two decades in Libya in order to identify the issues and to arrive at a suitable solution for managing C&D waste. Thus, there is set of regulations pertaining to waste management, the environment and the protection of the life of living organisms in Libya. However, the devolution of power to municipal governments has historically hampered their implementation, in addition to the instability in Libya due to its international political situation, including the on-going civil conflict. Figure (3.2) shows sequence of laws and regulations related to waste and environment management in the last five decades in Libya.

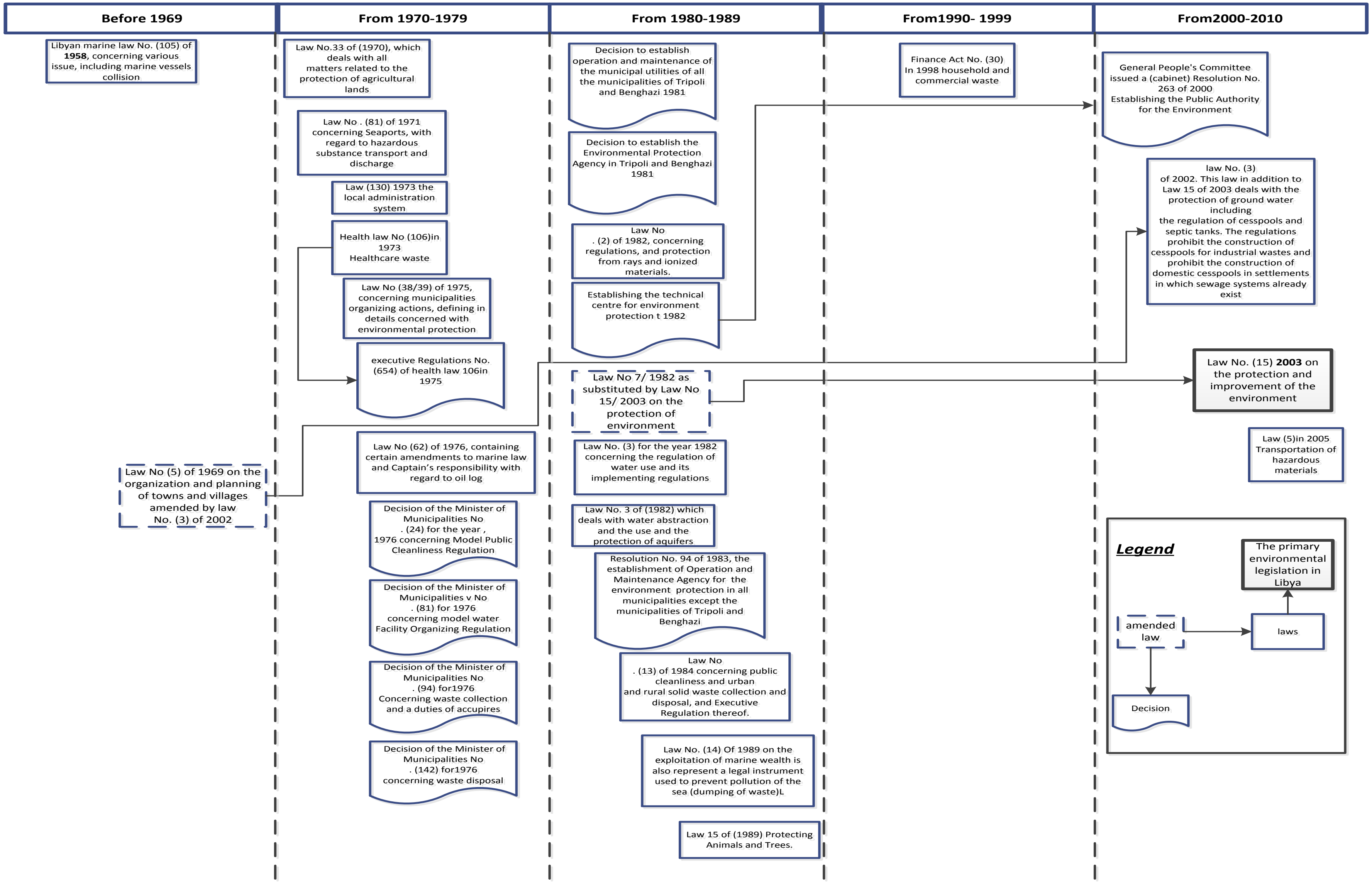


Figure 3-2: Sequence of waste and environment management laws in the last five decades in Libya

3.5 Institutional Framework for Waste and Environment Management

In the last four decades' SWM in Libya has been managed by different administrations. Before the late 1970s all waste collection and disposal was carried out by private companies who handled the collection and final disposal of solid waste, until such companies were nationalised and came under the auspices of municipal authorities. Subsequently, responsibility for waste management was transferred to Environmental Protection Agency and the General People's Committee for Housing, Utilities and Environmental Protection Authority, which later merged with Operations and Maintenance Authority (formerly called the General Companies for Cleanliness) and was charged with the responsibilities of street cleaning, parks and land maintenance, beach cleaning, and the collection, transfer and disposal of collected waste. According to Elfallah and Boargob (2005), the Secretariat of the General Peoples Committees for Utilities of Housing and Environment is responsible for solid waste collection, transport and disposal. Table (3.5) shows the historical outline of institutional frameworks for SWM in Tripoli.

Table 3-5: Developments in municipal SWM in Tripoli, Libya (1970-2006)

Period	Management agency	No of decree (resolution)
Before 1970	Private Sector companies	-
Until 1980	Municipality of Tripoli	-
1981-1986	Environmental Protection Agency	45/ 1981
1986-1987	Environmental Protection Agency + Operating and Maintenance System	192/1986
1987-1999	General Cleanliness Company	394/1987
1999-2003	Company of Public Authority	11/1999
2003 -2006	Company of Occupancies and Public Services	78/2003
2006	Tripoli Public Service Company	138/2006

Source: Etriki (2013)

Most recently, Local Authorities have been responsible for waste collection and disposal in each municipality, being charged with setting up places for the disposal of construction waste and end of life vehicles, either. In addition, municipalities must report on the quantity of recycled solid waste, composition and other key indicators to the Environmental Protection Minister. Therefore, in order to achieve the study aim, this study decided to identify ministries and institutions responsible for C&D waste management, which can help to understand current situation of waste management in the country and also to choose right sample for the questionnaires and FGD. Table (3.6) shows most recently ministries and institutions involved in waste management in Libya.

Table 3-6: Ministries and institutions responsibilities on SWM in Libya

Ministry/ institution	Established	Responsibility addressed
Environmental General Authority (EGA)	The supreme environmental authority in Libya, founded in 1982 to replace the Technical Centre for Environmental Protection. The General People's Committee for Health and Environment in 2000 established the EGA by Resolution No. 263	A separate, sovereign institution that accomplishes its responsibilities under Environmental Law No. 15 of 2003. The EGA has 7 provincial branches answerable for the application of national environmental strategy.
Ministry of Local Government	Resolution No. 55 of 2012 instituted the organisational structure and functions of the Ministry	In charge of solid waste collection through cleaning companies, C&D waste and source management of poisonous waste from hospitals and running landfill. In addition, answerable for drinking water quality. Entrusted with the protection of public health and promoting waste recycling and improvement of green areas in cities. Cooperates with Ministry of Agriculture to treat and reuse wastewater in agriculture.
Local Authorities/ Municipalities	-	Responsible for the storage, collection and disposal of MSW, they determine the legal and administrative arrangements for collection and disposal. Municipalities are also authorised to establish sites for landfills and to determine other waste disposal locations
General Service Company	-	Public Service Companies (PSCs) are responsible for waste collection and transfer in each municipality
Private companies	-	Subcontracting has been introduced, particularly since 2003, but responsibilities are not clear between the private and public sectors (Eltriki, 2013)

3.6 Current State of SWM

Libya suffers from inefficient municipal solid waste management (MSWM) and a lack of approved and sanitary landfills (European Commission, 2009). Libya has been ranked 123rd of 142th countries in terms of environmental degradation. Much urban solid waste is dumped and burned on empty plots within urban limits, with associated health problems. Much of the collected waste is deposited in dumps without consideration of the negative impacts of such dumping. Some of these are located directly on the coast, leading to marine pollution from leachates and severe littering of the coastline (ESI, 2002). Social disorganisation, inequitable levels of waste management, and lack of awareness of free city programs are common factors in fly tipping (Brandt, 2017).

Recycling operations in Libya are limited to organic material on a micro scale (Faras and Al Kario, 2004). Lamah (1990) investigated the sources and components of solid waste and the techniques of waste collection and disposal in Benghazi and found that 94.4% of solid waste is disposed of by conventional landfill, and just 5.6% is recycled composted using modern techniques; El-Treike (2000) found that SWM indicators have been severely exacerbated in Libya since the 1990s. Recently, Libya has faced serious contamination issues, especially in the large cities, due to huge quantities of waste. In fact, there is a general inefficiency in SWM; for example, collection and disposal services remain very poor. According to Elfallah and Boargb (2005), based on First National Environment Report, solid waste clean and reuse procedure participate to the recovery of part of the economic value of solid waste. In addition, it will participate providing more of work chances and financial income for the country. Introductory estimation a value of 121 Libyan dinars could be achieved every day for each ton of recycled domestic wastes in only 16 Libyan cities. Table (3.7) displays the possibility of waste recycling for 16 cities.

Table 3-7: Prospects of solid waste recycling in Libya

Description	Recovery rate %
Metal	85
Tissues	30
Glass	50
Paper and cardboard	60
Plastic	60

Source: EGA (2002)

However, as Saleh (2005) noted, the reality on the ground is that all types of waste are mixed together without any types of segregation, treatment or recycling (e.g. materials like plastics, paper and glass are collectively landfilled rather than separated and recycled to decrease waste and increase economic efficiency). The system of waste collection in Libya is generally ineffectively managed in all urban areas of the country, and waste discard is a big issue in all cities. Municipalities are struggling to efficiently collect the waste owing to the usage of unsuitable equipment (Saleh, 2005). Solid waste collection is the responsibility of the municipalities and private sector, and the main goal is preventing the accumulation of waste in the city (Etriki, 2013). Abdel Allah (2000) detected the reasons behind the accumulation of solid waste in the urban area, citing the deficiency of instruments and experienced labour, and the absence of funding for SWM schemes. The inadequate discarding of solid waste was determined to be an outcome of the absence of environmental awareness in public. While there are theoretical plans to address waste management issues in the foremost cities (Tripoli and Benghazi), there is no acknowledgement of the need to deal with these problems systematically in the rest of the country. Etriki (2013), 70% of solid waste collected by Tripoli public service company and private company only 8% is composed and 3% is recycled. Hamad *et al.* (2014) found that only 2% of waste in Libya is recycled. Eltriki (2013) noted that despite the immense economic potential of recycling and materials recovery in Libya, recycling activity is negligible. Table (3.8) illustrates recycling capacity in the country.

Table 3-8: Recycling capacity Table

waste	Quantity produced (tons/year)	Quantity recycled (tones/ year)
Paper	75,000	1,080
Textile	19,000	420
Metal	20,000	360
Plastics	26,000	660
Glass	9,800	480
Total	194,800	3,000

Source: Hamad *et al.* (2014)

Waste tipping is still a problem in most Libyan cities, and most landfilling is simply dumping waste into big holes in the ground close to major urban areas where the waste is generated. In addition, serious action has not been made by constructing engineered landfill sites to reduce harm and numerous problems to the environment around the city (El-Treiki, 2001; Saleh, 2005). Figure (3.3) captures the methods of solid waste disposal in Libya (Faras and Al Kario, 2004).

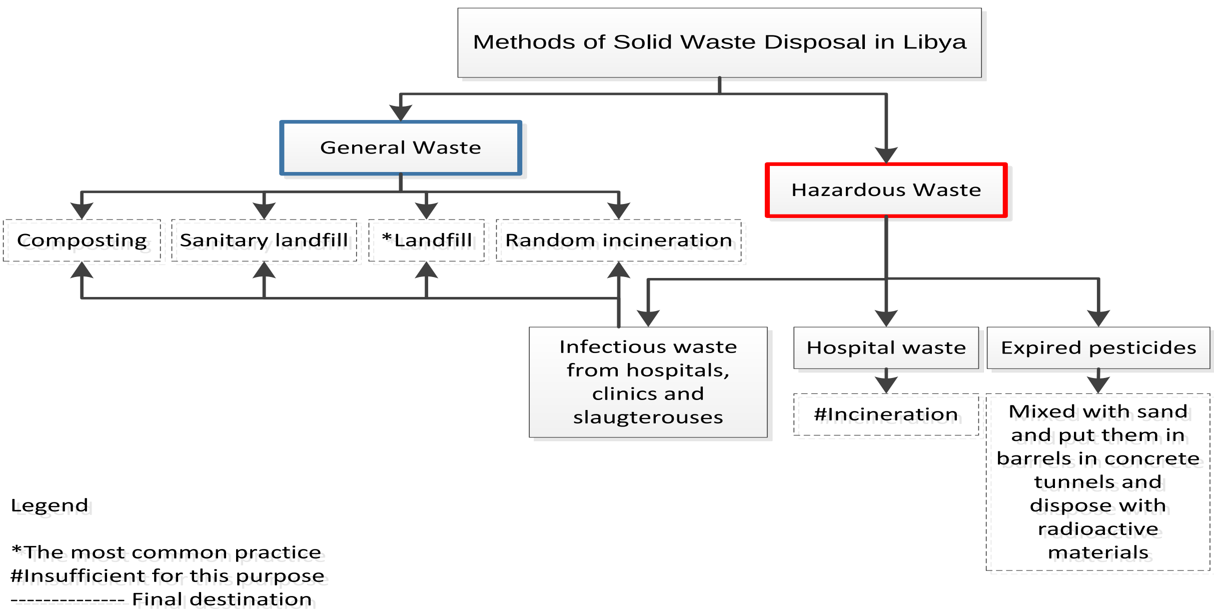


Figure 3-3: Methods of solid waste disposal in Libya (adopted form Faras and Al Krio, 2004)

As Rafik *et al.* (2013) observed, landfilling is particularly attractive to waste producers in Libya because it is cheap, and there is vast land available for this activity (most of the country is uninhabited desert); also, the lack of awareness that this activity is an unethical and antisocial behaviour can be inferred as a contributor when compared to developed countries. Currently, open landfilling is the most common method of waste discard for approximately 1.2 Mt of waste yearly in Libya (Omran *et al.* 2011), solid waste pollution in nearby Benghazi and within the urban perimeter (Gebril, 2013).

In addition, even official disposal sites are not far from the main cities, without any kind of protection for the environment and public health; for instance, the industrial and domestic waste of Tripoli is landfilled on three huge open disposal site close to the city, with inefficient management (Saleh, 2005). Landfill handling in the capital of Libya could be defined as open landfill site, which is not in line with Law no. 13 of 1984 for waste and cleaning, as shown in Figure (3.4). However, according to El-Treiki (2001), two former disposal sites were closed because of their impact on the surrounding air and the environment.

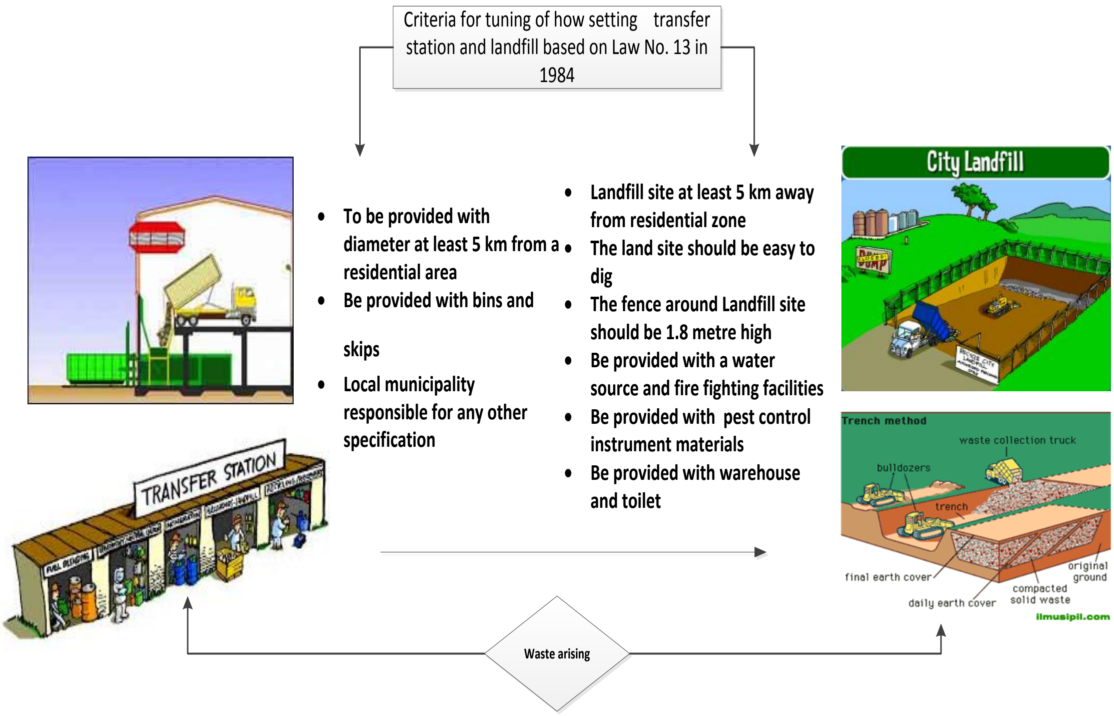


Figure 3-4: Landfill requirements in Libya based on Law No. 13 of 1984

Aboras (2006) indicated that general cleaning services in Al Abyar vary from one area to another. Due to a lack of delineation and environmental management, population increase, and the lack of tools and equipment for the collection and transportation of waste to landfill. This applies to many cities in Libya, for instance, in El Gubba city only two trucks are used to transport C&D waste (see Figure 3.5).

Figure 3-5: Condition of the equipment use for transporting of C&D waste to landfill (author photos)

3.7 Solid Waste Characterisation

Waste characterisation is a technique utilised to define the "character" or composition of materials contained in a waste stream. An itemised characterisation of solid waste is additionally essential for integrated SWM systems to be successful (Sakai *et al.* 1996). According to Brunner and Ernst (1986) and Martin *et al.* (1995), the most precise methods for characterising waste components is collecting waste at source and directly categorising it into several types of materials. Table (3.9) summarised solid waste components in Libya into three groups.

Table 3-9: Solid waste classification in Libya

"All domestic and similar waste households often discard such as paint, cleaners, oils, batteries, and pesticides that contain hazardous components. Leftover portions" (Saleh, 2005, p. 21).	**"Industrial wastes the waste generated by industrial, commercial activities, and special waste of an inflammable, toxic, corrosive or explosive character. It also includes old car bodies, debris coming from public and private construction works" (Saleh, 2005, p. 21).**	**"Septic wastes… from hospitals, clinics, pharmacies and laboratories, and corpses of small and large farms' waste" (Saleh, 2005, p. 21).**

Source: Saleh (2005)

In fact, the nature of waste generated in Libya varies remarkably over the seasons. The GEA (2003) estimated the level of waste production in Libya in 2002 to be 300.000 ton/ annually (organic waste) and 230,000 ton/annually (hazardous waste). Hamad *et al.* (2014) categorised solid waste in Libya into seven groups, as shown in Table (3.10).

Table 3-10: Category of solid waste in Libya

waste category	waste components
Biodegradable waste	Food and kitchen waste and green waste
Recyclable materials	e.g., paper, glass, bottles, cans, metals, and certain plastics
Inert waste	e.g., construction wastes, demolition wastes, dirt, rocks,
Composite waste	e.g., clothing and tetra packs
Plastics waste	e.g., toys
Domestic hazardous waste	-
Toxic waste	e.g., medication, e- waste, paints, chemicals, light bulbs, fluorescent tubes, spray cans, fertiliser, pesticide containers, and shoe polish

Domestic solid waste generation comprises 36.3% organic matter and 32.5% recyclable materials such as glass, paper, plastic, metals. The composition and rate of solid waste generated in Libya differs based on the location and income level of the city (Saleh, 2005). Figure (3.6) illustrates the proportion of MSW composition, and Table (3.11) shows the changing MSW composition rate in the country.

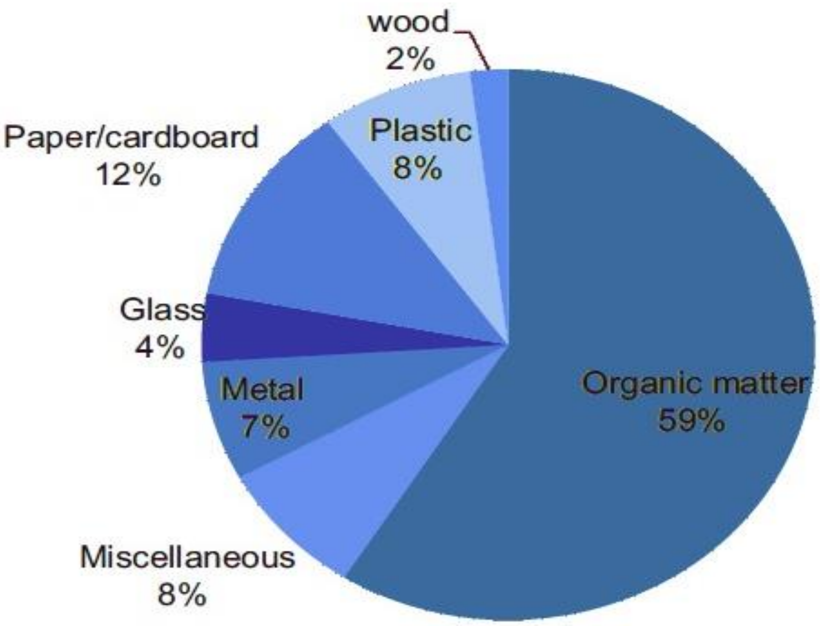


Figure 3-6: Proportion of MSW composition (Hamad, 2014)

3.8 Solid Waste Generation

A study by the Ministry of Housing and Public Utility in 2004 revealed that the per capita generation of solid waste in Tripoli city was 0.77kg/day. This was confirmed recently by Moftah *et al.* (2016), who found that the average household in the Tripoli area generates 0.7 kg of waste per day, and revealed that the rate of waste generation often varies remarkably within different zones of the same area (e.g. the waste generation rate was found to be 0.59 and 0.74 kg/capita/day in areas 1 and 2, respectively, and 0.78 kg/capita/day in area 3). Another study by Hamad *et al.* (2014) reported that solid waste average rate is 1.12kg/capita/day. On average, Faras and Al Kario (2004) reported that each Libyan citizen generates between 0.35 kg/day to 2.00 kg/day of MSW, with an average of 0.78 kg per capita.

In the absence of accurate data on municipal waste generation, the relevant authorities (the Ministry of Housing and Public Utilities (MHPU), the Municipality of Tripoli (MT) and Tripoli Public Service Company (TPSC) agreed to use the value of 1.0 kg per person per day of municipal waste (household, commercial and services waste combined) as a standard to calculate the quantities of solid waste generated within their jurisdictions and for contract procedures. Etriki (2013) demonstrated that the total quantity of MSW generation is expected to increase by an average of 2.5% from 6.64 million tonnes in 2010 to 11.68 million tonnes by 2020, and the quantity of waste generated per capita is expected to increase from 1.090 kg/ person/day to 1.290 kg/person/day by 2030. According to Abukersh (2009), the annual tonnage of C&D waste produced in Libya is estimated in the range of 400-450 kg per capita.

Gebril (2010) and Hamad *et al.* (2014) estimated that the overall generation of industrial solid waste, including non-hazardous wastes, industrial wastes and C&D waste, comprises 1.248.000 tonnes/year, with an accumulated quantity of 2.196.480 tonnes. Ali *et al.* (2016) estimated that Libyan C&D waste based on annual cement consumption was 3,641,150 tonnes in 2010. Figure (3.7) shows C&D waste arising in Libya from the period 1992-2010.

According to Sabai (2013) the generated quantity of C&D waste could be estimated from regular C&D works, but this is increased exponentially by natural or man-made disasters like earthquakes or conflicts (e.g. Beirut in 1975, 1990 and 2006; Kobe in 1995; Mostar in 1992-1994; Italy in 2009; and Chile in 2010) (Chan *et al.* 2000). Correspondingly, the on-going conflict in Libya exacerbated the quantity of C&D waste by destroying infrastructure, post-war reconstruction and the decimation of the already limited infrastructure to process such waste. In the light of recent events in Libya, C&D waste has increased tremendously and hence the need to ensure proper management.

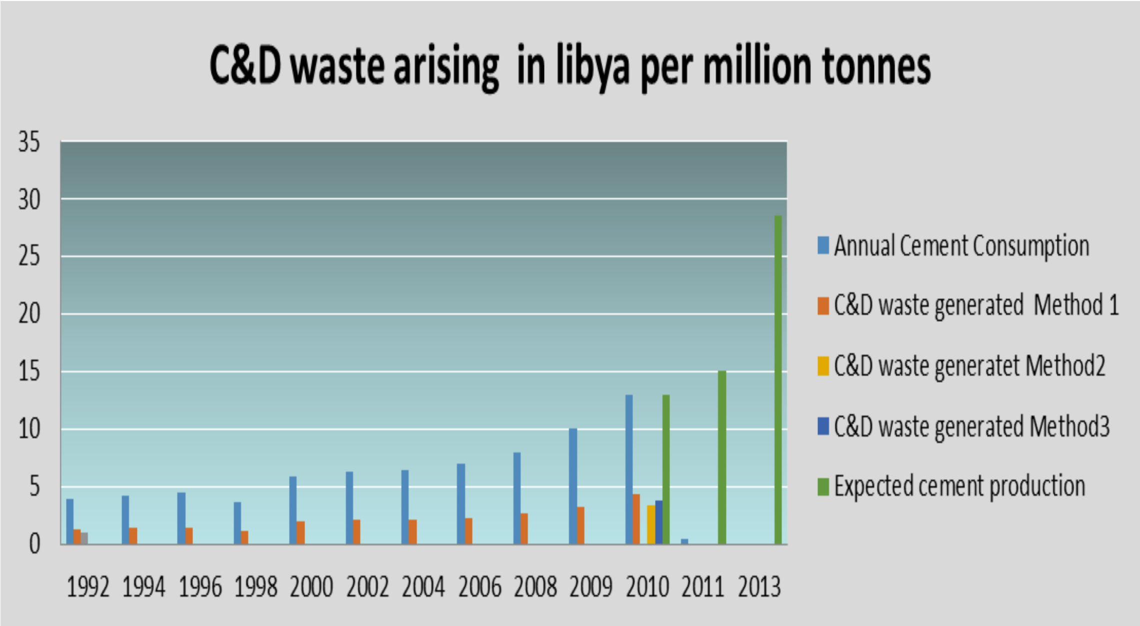


Figure 3-7: Quantity of C&D waste arising in Libya by different methods (Ali et al. 2016)

3.9 Summary

Despite the global direction towards SC&DWM, Libya and other developing countries continue to face intractable problems, with poor performance and a lack of legislation and enforcement.

This chapter reviewed SWM in Libya in terms of legislative and institutional frameworks. The country profile has been considered, including the socio-demographic, geographical and economic dimensions with regard to the construction sector. It has been shown that there is a lack of waste management in general. Meanwhile, the volume of mismanaged (i.e. unmanaged) C&D waste continued to balloon due to development, urbanisation and population increase, exacerbated by the conflict since 2011. The following chapter presents some cases where increased C&D waste was encountered as a result of natural or manmade disasters and pilot study on barriers to sustainable management of PC/C&D waste.

4 PILOT STUDY – BARRIERS TO SUSTAINABLE MANAGEMENT OF POST-CONFLICT C&D WASTE AND CONCEPTUAL FRAMEWORK DEVELOPMENT

4.1 Introduction

The chapter provides a brief review of some cases involving natural or man-made disasters (e.g. conflict, war and earthquake), reviewing the benefits of managing such waste. The chapter also presents the findings of the pilot study conducted to identify the main barriers facing managing C&D waste results of PC situations, as experienced in Libya (see Appendix 1A). The research adopted a mixed approach, including both quantitative and qualitative methods. The quantitative phase was based on a three-stage investigative procedure:

1. Pilot study leading to a conceptual framework;
2. Pilot (trial) survey based on the conceptual framework (but open to an evaluation by proposed respondents); and
3. The main survey, based on the outcome of the pilot in (2).

A pilot study is a small experiment designed to collect and examine logistical and methodological information about a main study in order to fine-tune the instruments subsequently deployed. This improves the quality and efficiency of the main study (Lancaster *et al.* 2004). The pilot study was conducted to identify any similarity in barriers facing C&D waste results of both PC and normal construction activities, and to develop the conceptual framework accordingly. To distribute the pilot study questionnaire a mailing list was used. A Facebook Page was also created for people interested in the management of solid waste in Libya, the main objective of which was to connect with the largest number of experts in the field of environment and waste management and the construction sector. Questionnaire administration was carried out using self-administered approach (with Google Forms - Google Docs). In total, 79 questionnaires were sent out and 59 returned, indicating a 74.6% response rate. Table (4.1) shows categories of pilot study participants. Data analysis was carried out using Statistical Package for the Social Sciences (SPSS) version 20.0. Based on the results of data analysis, a framework for management of PC (C&D type) waste was developed. This demonstrates the need for an integrated framework for management of C&D waste generated from both normal construction activities and PC in Libya, and facilitates the development of the conceptual framework.

Table 4-1: Category of pilot study participants.

Category of participants	Average of experience	Number of participants
General service companies	7	11
Environment General Authority	6	10
Environment Committee in Libyan Parliament	8	5
Waste management private companies	4	7
Construction sector	5	9
Authors and people interested in PC and C&D waste management	6	17
Total		**59**

4.2 Disasters and Post-Conflict Construction Waste Management

Disaster and disruption can be natural (e.g. floods, drought, volcanic eruptions and earthquakes) or man-made (e.g. conflicts and terrorist attacks); both result in similar problems in terms of the destruction of infrastructure, and various physical and social impacts (Brown *et al.* 2011). Wars and conflicts often result in the production of waste due to destruction or damage done to properties and infrastructure. The volume of waste produced by wars and conflicts over a relatively short period of time can sometimes equal many times the quantity of annual waste generation in peace time. The largest component of urban disaster waste would meet the peace-time classification of C&D waste (Dubey *et al.* 2007). Throughout conflict and into PC periods, rehabilitation and reconstruction works generate significant C&D waste from destroyed buildings and other infrastructure. For example, in the city of Mostar over 1000 buildings were destroyed, which was estimated to generate about 200,000 tons of C&D waste (Lauritzen, 1995). Therefore, it is impossible to avoid waste during disaster, thus waste minimisation is the main priority (Karunasena and Amaratunga, 2016). In addition, as a result of destruction caused by prolonged conflicts, it is often difficult to implement long-term environmental policies; in such situations, short-term waste management strategies are required to achieve immediate objectives, for example the restoration of dumpsites following uncontrolled open dumping of waste in unauthorised locations (Lauritzen, 1998; Petersen, 2004). It is however necessary to indicate that PCW management strategies depend on specific contexts such as regional situations. In general, previous studies indicate that knowledge of disaster waste management is difficult to transfer from one event to another (Brown, 2012).

4.3 Quantity of Post-Conflict C&D Waste in Libya

During the 2011 conflict in Libya, enormous quantities of C&D waste were generated. Elzahari *et al.* (2013) calculated that more than 45,000 housing units needed rehabilitation or rebuilding, and the percentage of removal and maintenance of buildings was as shown in Figure (4.1). Consequently, the volume of C&D waste comprises more than 80 million tons, more than 15 European countries combined, and 22 times the quantity of C&D waste estimated in 2010 by Ali *et al.* (2016), and about three times the total C&D waste generated between 1992-2010. This quantity generated from total damaged buildings of about 90,282 units of residential and government buildings (e.g. the defence, education, hotel and health sectors) in 2011, with different levels of damage, as shown in Table (4.2). This gigantic volume of C&D waste needs coordinated strategies to be managed, and recycling must play a role in the management of this waste.

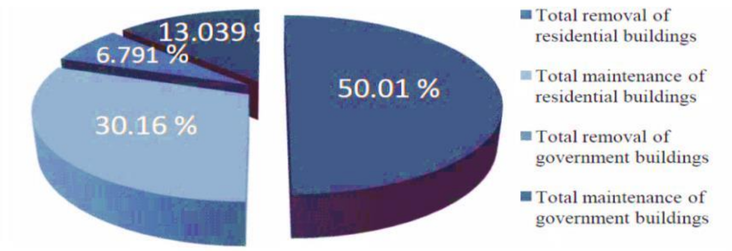


Figure 4-1: Percentage of removal and maintenance building after 2011 conflict (Elzahari et al. 2013)

Table 4-2: Building requirements survey data after 2011 conflict

Name of Building	Total number of damaged buildings	Total number of buildings needing maintenance	Total number of buildings need rebuild
Public buildings	1658	1111	547
Residential building	43483	40633	2850

Source: Elzahari *et al.* (2013)

4.4 Sustainable PCW: C&D Debris

C&D waste production is inescapable in itself, and the problem is multiplied in conflict and PC scenarios due to the destruction of infrastructure and reconstruction activities, compounded by military and medicinal waste (from humanitarian assistance) all of which impose extraordinary burdens on facilities to process waste, bearing in mind that institutional bodies are generally weakened by conflict (Mensah, 2006). Post-disaster management of C&D waste comprises normal processes of waste management, including collecting, transporting, processing and landfilling waste produced by several activities such as demolitions and reconstruction through relief or waste management processes (Karunasena *et al.* 2013). C&D waste is often collected and mixed with other urban wastes and disposed together, reducing the capacity of gathering vehicles and overburdening non-recyclable waste facilities (United Nations, 2003). C&D waste worldwide mainly comprises concrete, reinforced asphalt, brick, tiles, mortar, soil, rock, rubble, sand, bamboo, glass, fixtures, plastic, slurry, sludge, plants, wood and other kinds of organics and wreckage (Poon *et al.*, 2001). All kinds of buildings were damaged, as shown in Figure (4.2).

Figure 4-2: Types of buildings damaged in Benghazi/Libya

Particular waste generated in extraordinary conditions such as after disasters undergoes several phases, as shown in Figure (4.3). However, according to Planning Centralised Building Waste Management Programmes in Response to Large Disasters, there is a slight difference between PC and natural disaster waste processing, as shown in Table (4.3).

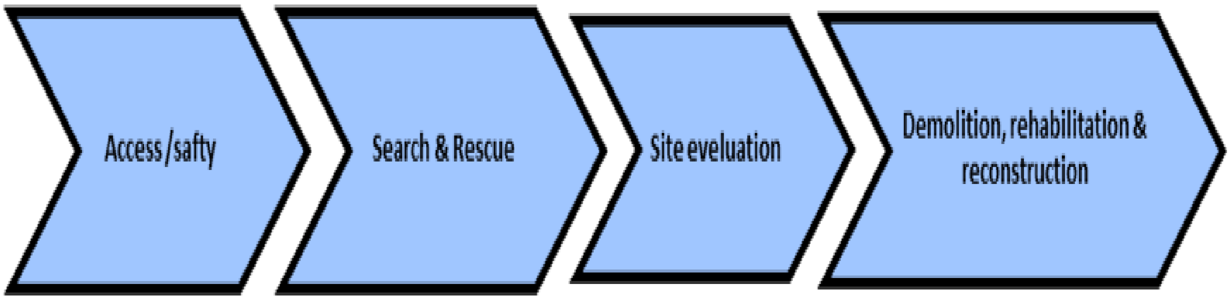


Figure 4-3: Phases of nature and man-made disasters waste generation (Ali and Ezeah, 2017)

Final disposal is the most significant long-term issue in PCW management. Generally, in many PC situations, nearby landfills are the principle resources used for waste disposal, but a significant number of them are ineffectively sited, and designed with no pollution aversion measures (Calo and Parise, 2009). In addition, Brown *et al.* (2011a) uncovered a number of shortages in existing legislation even in developed countries, and in the authoritative structures and financing instruments identified with disaster waste administration. However, some authors such as Ardain *et al.* (2009) consider that disasters can offer chances to rescue substances via reuse and recycling to embed habits of sustainable industrial development.

Table 4-3: Differences between post-conflict and disaster waste

Post-conflict building	Disasters waste
"Waste often contains reduced amounts of timber, furnishings and personal possessions since the buildings will often have been burned. In post-conflict situations there is, however, a risk of unexploded ordnances (UXO), mines and booby traps being present in the building waste. In such instances, access should be restricted until professionals have first cleared the area" (Humanitarian Response, 2013, p8).	*"The nature and scale of waste following a disaster varies considerably from one situation to another. In post-tsunami situations, for instance, the majority of solid building waste could be washed out to sea by the receding waves. What may remain, however, is a large volume of mud into which other materials may be mixed, which may prove difficult for sorting. In contrast, post-earthquake debris will often have all of the materials from the buildings still present at the footprint of the building". (Humanitarian Response, 2013, p9).*

4.5 Post-Conflict and Disasters Waste Management in Libya

As mentioned earlier, Libya suffers from inefficient waste management. In recent times, despite Libya being particularly active in environmental protection legislation relative to African standards, no significant action was taken to promote sustainable economic development, including with regard to the construction sector and waste in general, and no strategies were formulated for waste management, especially in terms of legislation for conflict and disaster waste.

There are no explicit laws except Law No. (11) for the year 1971 regarding civil defence, which merely mentioned some procedures (e.g. organizing the detection of unexploded bombs and lifting operations, preparing teams and rubble removal, and organizing equipment and tools and warnings for air raids), and Decision No. 184 of 2012, concerning citizens' compensation in cases of natural disasters and calamities. Therefore, Libya has no efficient or clear strategies to deal with conflicts and disasters waste issues, which is probably due to Libya not having faced significant natural disasters or conflicts for a considerable time between 1945 and 2011. This is because these issues are not perceived as urgent among those responsible for decision-making.

The fundamental difficulties in developing countries for managing disaster waste are absence of related policy framework, harmony between pertinent government levels, departments and stakeholder involvement. In addition, insufficient capital and capacity are also regarded as problems related to disaster waste management. In many nations, waste management is basically concentrated on SWM. Disaster and C&D wastes are not well defined in national and local frameworks (Memon, 2016).

4.6 Benefits of PCW Recycling

Many studies show the environmental, economic and social benefits of recycling PC and disaster debris, including in terms of decreased disposal site area used, reduced claim for natural materials, reduced transportation impacts for raw and debris materials and job creation, discovered from cases such as the Northridge Earthquake in the US in 1994 (Gulledge, 1995; USEPA, 2008), Thailand and Sri Lanka (Basnayake *et al.* 2005; UNDP, 2006), Kosovo (DANIDA, 2004) and Beirut (Jones, 1996). However, many authors indicate some barriers for recycling C&D

wastes after conflicts and disasters (Solis *et al.*1995; Lauritzen, 1998; Baycan and Petersen, 2002; Brown, 2012).

4.7 Barriers to PCW Recycling

Recycling is decisive in C&D waste management, but many barriers have been identified that inhibit PC/C&D waste recycling, as summarised in Table (4.4).

Table 4-4: Barriers to post-conflict waste recycling

Barriers	Title of study	Reference
The time to collect and process the materials	Disaster waste management	(Baycan and Petersen, 2002; Brown, 2012)
Lack of specialists in PCW management	Disaster waste management	(Baycan and Petersen, 2002; Brown, 2012)
Lack of specialised equipment	Disaster waste management	(Baycan and Petersen, 2002; Brown, 2012)
the inability to physically separate the materials	Emergency construction waste management/ Emergency planning for disaster waste: a proposal based on the experience of the Marmara Earthquake in Turkey	(Lauritzen, 1998; Baycan, 2004; Brown, 2012)
The lack of desire to offset raw material use in rebuild	Emergency construction waste management	(Lauritzen, 1998)
Unavailability of disposal sites	Emergency construction waste management	(Lauritzen, 1998)
Unavailability of markets to absorb large quantities of material	Disaster debris management/ emergency construction waste management	(Solis *et al.* 1995; Lauritzen, 1998; Brown, 2012;Salemdeeb & Bjerregaard, 2014).
Contractual arrangements	Disaster waste management: A systems approach	(Brown, 2012)
Availability and feasibility of alternative waste management options	Disaster waste management: A systems approach	(Solis *et al.*1995; Brown, 2012)
Hazards in the waste matrix	Disaster waste management: A systems approach	(Earthquake waste Symposium, 1995; Brown, 2012)
Displaced population	Disaster waste management: A systems approach	(Brown, 2012)

4.8 Strategies for Managing Post-Conflict C&D Waste

PCW management strategies are a crucial step to forming a waste management framework. In this case the strategy contains three phases, as shown in Figure (4.4), which shows C&D waste results of conflict mostly has the same process compared with the process of C&D waste resulting from normal construction activities.

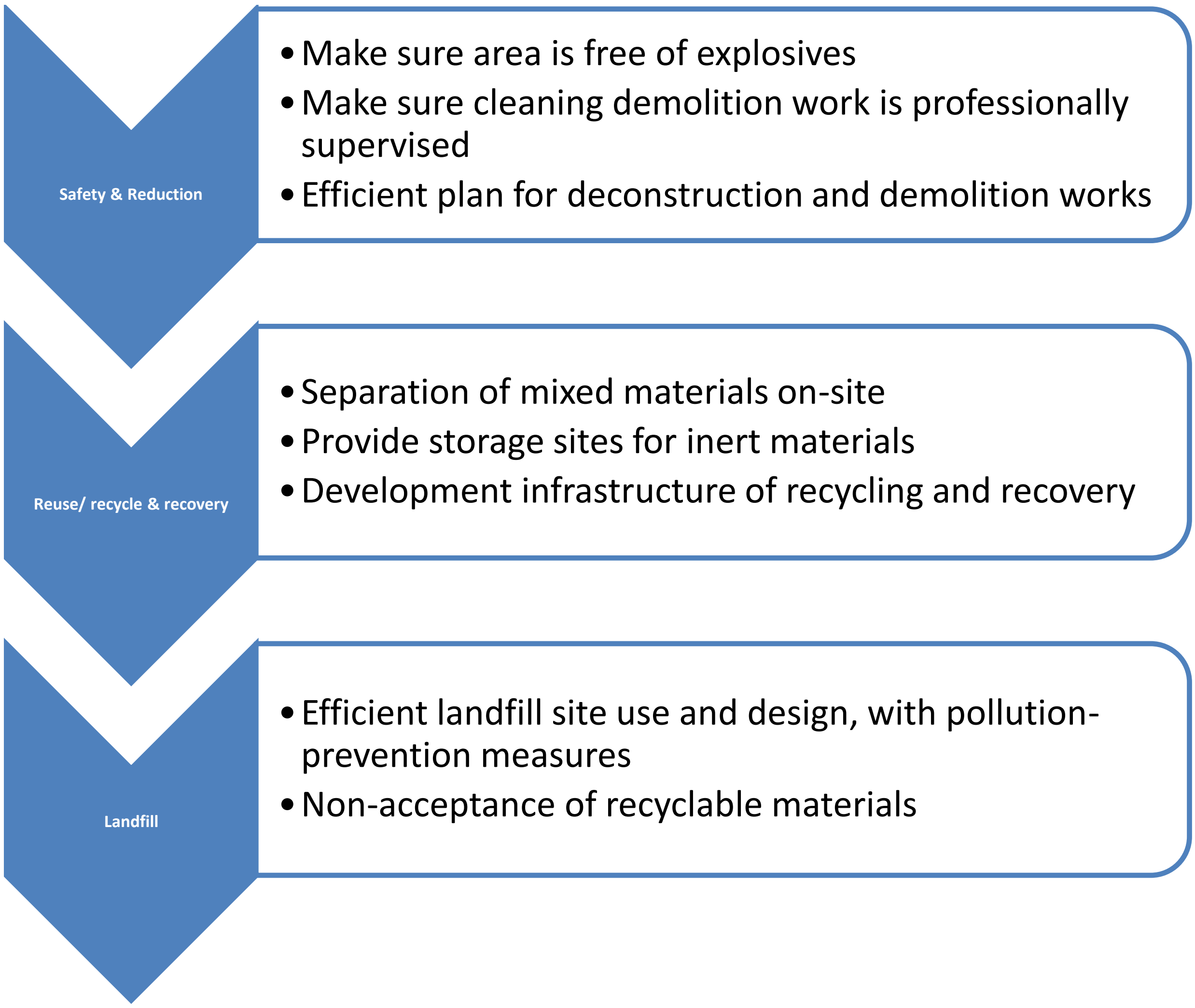


Figure 4-4: Conflict waste hierarchy
(Ali and Ezeah, 2017)

4.8.1 Safety and Reduction

Removing PCW is a crucial task; in order to bring life to the affected areas and assess the damage as soon as possible, access must be opened, rubble removed and unstable structures cleared to provide immediate safety and prepare for clean-up and reconstruction. The International Committee of the Red Cross noted that the international armed conflict in Libya in 2011 has resulted in widespread pollution throughout the country, with a large amount of abandoned munitions and unexploded ordnance, therefore professional bomb disposal units and technologies are necessary for the removal of PCW prior to conventional construction industry activities. PC materials can be safety managed, with minimum quantity going to the landfill, as presented in the route shown in Figure (4.5).

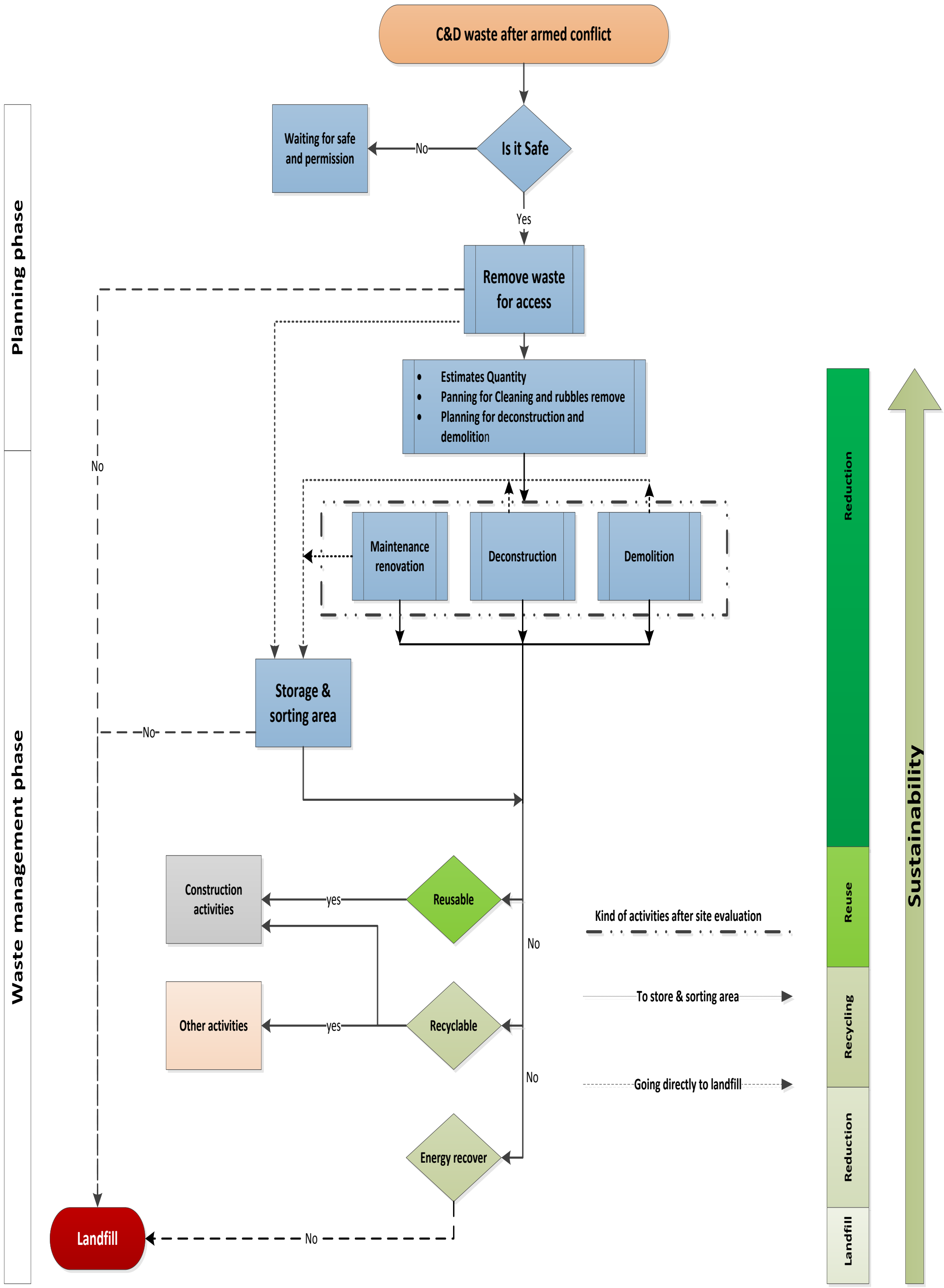


Figure 4-5: How post-conflict materials are safely managed based on using waste Hierarchy, with minimal quantities for landfill
(Ali and Ezeah, 2017)

4.8.2 Reuse and Recycling

Many materials in PCW can be reused and recycled. For instance, concrete aggregate, soil for landfill cover and plant material for compost (Channell *et al.*

2009). From a simply practical perspective, recycling of construction waste is just alluring when the recycled items are competitive with virgin resources in terms of cost and quality (Lauritzen, 1998). Figure (4.6) illustrates the economic aspects of recycling, whereby the plausibility of recycling is subject to the expense of waste transfer (counting transportation), and the estimation of the value of the recycled substances related to the ease of use of the product and the expense of crude substances. Incentives are often provided to guarantee the economic value of recycling, but environmental advantages are the main rationale for recycling in the construction industry. Figure (4.6) shows the difference between conventional demolition handling and demolition and reusing/recycling. Figure (46, I) shows demolition materials just sent to the landfill or open areas, which also shows cost of transportation of demolition materials (B). Figure (4.6, II) shows how transportation removal of demolition materials (B) and raw materials supplied (A) and their commensurate costs are reduced by reusing/recycling these materials, with new material (X) being reused in the same project.

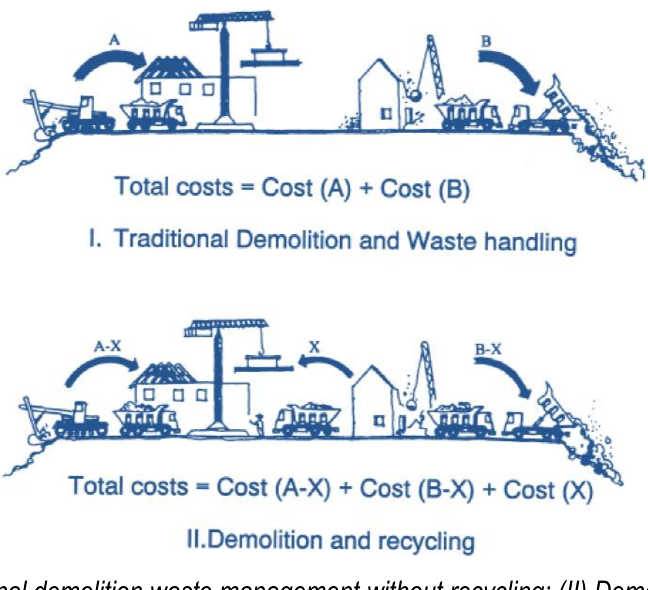


Figure 4-6: (I) Conventional demolition waste management without recycling; (II) Demolition waste management without recycling
(A) Quantity of natural materials; (B) quantity of transportation and disposal of waste materials; (X) quantity of recycled materials
Source: Lauritzen (1998)

In numerous expansive scale disasters, the quantity of waste surpasses dumping site limits (Petersen, 2006). For instance, after Hurricane Katrina, open resistance to the extended waste approval standard at C&D landfills prompted a claim being recorded and the possible closure of one landfill site, thus waste administrators were compelled to discover an alternate dumping site (Luther, 2008). Landfill should be the last option on PC/C&D waste for elements which ordinarily would need to be disposed, and sites should be designed efficiently, with pollution-prevention measures.

4.9 Challenges

There are many challenges to managing C&D arising after conflict in Libya. (e.g. the spacing between the affected areas). Figure (4.7) shows NATO places of operations in Libya in 2011. As in many developing countries facing PC disasters, waste handling lacks a relevant policy framework, harmony between relevant government levels and sectors, stakeholder engagement, and technical capacity. Furthermore, conflict is on-going in some areas.

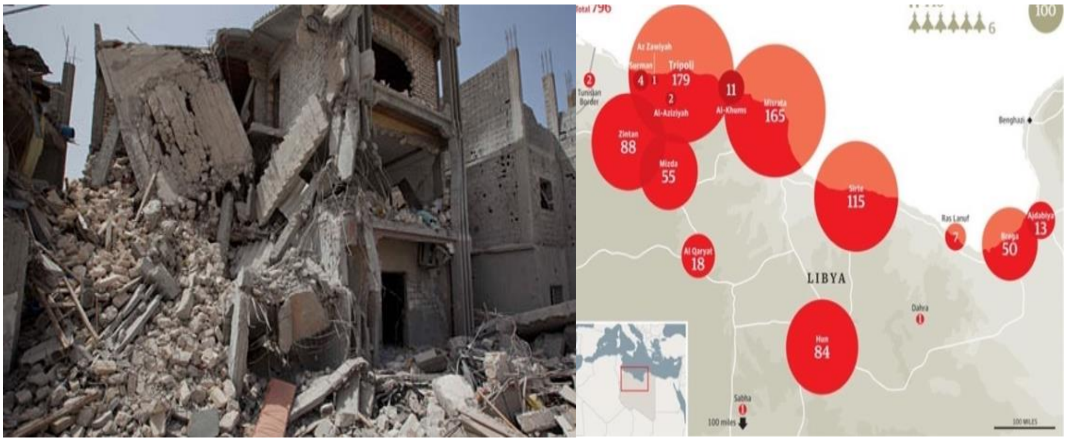


Figure 4-7: NATO operation and type of damage in Libya in 2011
(The Guardian, 2016)

4.10 Results and Discussion on PC/C&D Waste (Pilot Study)

The review of literature identified a list of 11 barriers to recycling and reuse of PC/ C&D waste. In this field, the pilot study proved the barriers identified in the literature. However, the questionnaire identified 9 more barriers to recycling and ruse of PC C&D waste in Libya:

1. Many participants in this survey raised the issue of the lack of studies demonstrating the importance of this issue.
2. Most participants felt that the government does not give serious attention to this issue.
3. Determining responsibility for waste management in Libya is the most immediate obstacle to take advantage of this waste.

4. There is lack of institutional responsibility to manage this type of waste.
5. There are no laws explaining how to deal with this type of waste.
6. There is no censorship on the kind of projects which cause failure.
7. The public lack awareness of the importance of recycling and they fear that recycled construction materials are unsafe.
8. There is no support from the government to encourage private sector involvement.
9. There is inadequate financial support.

Figure (4.8) shows the major areas of commonality of barriers identified by the literature and by analysis of the questionnaire. Figure (4.8) shows the most important barriers is lack of specialised equipment. The barriers could be categorised under five main dimensions: Specialists in PCW management, Equipment and facilities, Policy and governance, Cultural perceptions and Research and study. To bridge this gap and overcome these barriers, this section of study proposes a conceptual framework to develop organisations' capacity and their ability to carry out their functions and achieve desired goals.

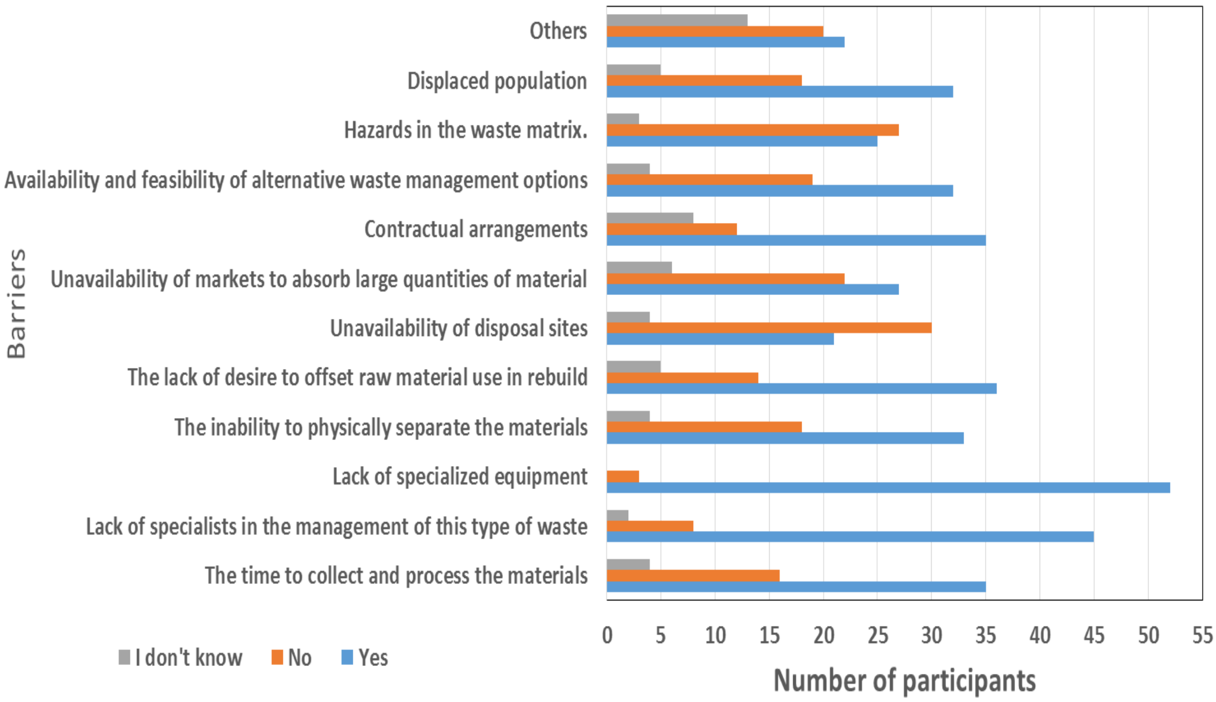


Figure 4-8: Barriers identified by participants to recycling and reuse of C&D waste results of post-conflict

4.11 Framework for Managing Post-Conflict C&D Waste

Flows of C&D waste and other forms of PCW are a long-term problem necessitating long-term solutions integrated in reconstruction activities. Therefore, to overcome and minimise PC/C&D waste, the framework is organised into five conceptual phases based on capacity building and Waste Hierarchy, as proposed in this study. Figure (4.9) illustrates the proposed framework. Notably, responsibility is accorded regarding the safety and rights of people working in such circumstances, which are characterised by high risk. This is by issuing legislation governing dangerous activities, as part of which pre-emptive emergency and risk assessment is necessary before commencing any work. In the second phase, estimation of the quantity of C&D waste and the right way and pace of sorting it are established. Research and training for choosing the right way for sorting and estimating the quantity of C&D waste should be considered, as not all ways of C&D waste quantity estimation and sorting are applicable for all contexts.

In the third phase, transformation, focus is on reducing negative environmental impacts on quality and ensuring the compliance of the materials with national standards for construction activities, which continues in the subsequent phases. This is by ensuring the reuse of C&D waste in the same area or project where applicable.

The fourth phase entails several approaches for resource creation by increasing the rate of recycling, by providing proper support such as infrastructure development. Also, all procedures to create marketing for recycling materials need to be considered.

The final phase is waste disposal, which is the last (and least preferred) option in the management of C&D waste resulting from the conflict in Libya. This option is only used if all previous options are not applicable. In addition, all of these phases must be fostered by legislative and regulatory input. It should be noted that early, thorough design and techniques to manage PC/C&D waste sustainably comprise the most fundamental determinant of success (Alameda County Disaster Waste Management Plan, 1998; Baycan and Peterson, 2002). The technique proposed by this framework is to be implemented as part of the construction phase to achieve the main aim of the study.

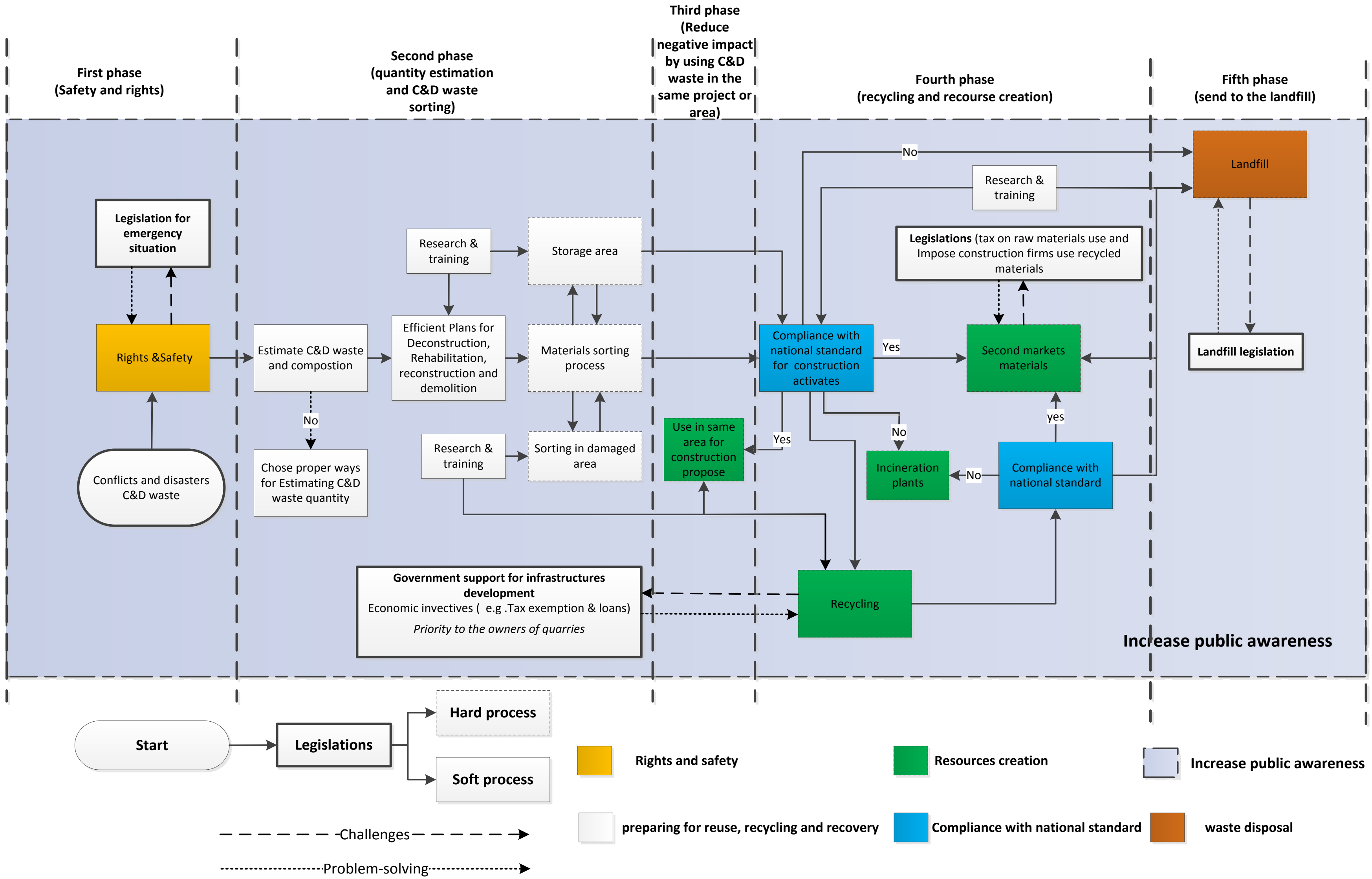


Figure 4-9: Framework for management C&D waste after armed conflict in Libya

4.12 The Need for an Integrated Framework

This section of the research proposes a framework for PC/C&D waste produced in Libya. Generally, the study detected that there are considerable hurdles to recycling and the reuse of PC/C&D waste in Libya, which previous studies revealed to be universal. Therefore, to avoid these barriers the Libyan government should take quick actions to promote infrastructure development and issue laws to manage this type of waste. Legal provisions should outline the rights of stakeholders involved in the management of PC/C&D waste, which usually includes high risk materials.

Investment and inviting construction firms to participate in reconstruction using materials in compliance with required specifications can initiate the rebuilding of the Libyan construction sector and the national economy as a whole. This pilot study covers only PC/C&D waste, and did not focus on the ways of avoiding C&D waste in general, since this type of waste is unavoidable and limited to certain areas, or (hopefully) for a limited time in Libya. Furthermore, the major proportion of PCW is C&D waste, and the management of both types is similar. The most important differentiation in the case of contamination and remnants of conflict is to conduct a thorough risk assessment for harmful chemicals and weaponry, making necessary adjustments to protect the people involved and ensure their safety. The current absence of a clear programme for the management of C&D waste in Libya, despite the accumulation and the possibility of increasing in quantities during reconstruction phases, is a major problem, therefore it is urgently necessary to integrate a framework to manage C&D waste resulting from both types of waste. Thus, the following section shows the process needed to develop a conceptual framework for managing C&D waste results of both general construction activities and PC in Libya.

4.13 Development of Conceptual Framework

To answer the research questions requires an understanding of the interrelation between the anticipated outcomes of SC&DWM, legislation and policy. From the analyses conducted in the literature, there is a sign that C&D waste management includes numerous tools in addition to waste management legislation. Therefore, a comprehensive understanding of the different parts of C&D waste is necessary to develop a framework for SC&DWM, involving the different angles and ideas within

C&D waste and mapping into an action plan (framework) for implementation by practitioners.

A framework more often indicates a structure, overview, outline, system or plan comprising different descriptive classes relating to concepts, constructs or variables associated with a phenomenon (Sabatier, 2007). "*A theoretical framework is derived from an existing theory (or theories) in the literature that has already been tested and validated by others and is considered a generally acceptable theory in the scholarly literature"* (Grant and Osanloo, 2014, p. 16). Waste management theory is predicated on the undesirability of waste in itself, and the desire to institute measures to prevent waste arising and its associated harms to the environment and human wellbeing. The key to sustainable waste management is waste minimisation, specifically the reduction of waste at source, therefore the theoretical framework in this study sought to identify the gaps in knowledge and what questions need to be answered or what problems need to be addressed. This also helps in formulating the conceptual framework of the study to serve as guide. Miles and Huberman (1994, p.18) noted that a conceptual framework is a visual or written product that "explains, graphically or in narrative form, the main things to be studied, the key factors, concepts, or variables, and the presumed relationships among them". Likewise, a results framework is:

> "an explicit articulation (graphic display, matrix, or summary) of the different levels, or chains, of results expected from a particular intervention—project, programme, or development strategy. The results specified typically comprise the longer-term objectives (often referred to as 'outcomes' or 'impact') and the intermediate outcomes and outputs that precede, and lead to, those desired longer-term objectives" (Roberts and Khattri, 2012, pp.7).

While the distinctions between outputs, outcomes and impacts remain debatable, the most expedient method is to deem outputs as the specific goods or services provided by an intervention, while an outcome is conveniently considered as advantages of that specific good or administration to the objective populace. An impact alludes to whether outcomes are really altering phenomena of concern (Roberts and Khattri, 2012., pp.7).

4.14 The Framework Justification

Toward the start of a policy development it is fundamental to be evident about the aim for the policy and how policy will help to overcome the issue under consideration (Bonehill, 2007), followed by research analysis and direction setting, in which data is collected and analysed to ascertain what is known of the research subject, picking up perspectives and analysing facts, and searching for lessons learnt and best practice that we can adopt from other countries. The purpose of the framework is to identify ways in which to overcome the lack of C&D waste management and divert C&D waste sent to landfills and minimise C&D waste, also to enhance the rate of reuse, recycling and recovery (3R) in Libya for such waste. The framework precedes a formulation of how the various phases link to another, in order to reach the desirable results, which is to encourage 3R. To reach the desirable outcome, some inputs must be implemented in practice, which involves in successful operation to demonstrate utility.

This framework represents a conceptualisation of how the diverse steps follow with one another in reaching the coveted outcome, which is to promote SC&DWM, requiring the input of a waste management system, which is then put into some essential strategies or instruments to obtain the needed outcome. In order to achieve that, the essential instruments may face some barriers that must be addressed using particular strategies. Also, some complementary strategies may have to be undertaken to avert or address any negative effects that may be linked with the instruments implementation. Along these lines, the structure is shaped by the accompanying sections: the input, principle of sustainable waste management, strategies including capacity building and enforcement; negative impacts and complementary strategies for avoiding or addressing these impacts; and positive outputs and outcomes. These components are examined in the following subsections.

4.14.1 Inputs

An input is something the government puts into its waste management system to obtain the desired result of developing C&D waste management in the country. For this situation, the input is to engage in the principle of SC&DWM in its waste management system. SC&DWM starts by absorbing the concept of principles of

SC&DWM. Therefore, the government needs to first guarantee that its personnel and partners comprehend and apply the principles of managing C&D waste in a sustainable manner (pre-strategies). The implementing of these principles is thus the endpoint of a preliminary road map for applying SC&DWM.

4.14.2 Strategies

Following the implementation of SC&DWM principles, the government undergoes particular physical and nonphysical strategies. These strategies may involve implementing the best C&D waste management practices to address the relevant waste management issue facing the government. The selection and implementing of SC&DWM practices is defined by what we want to obtain. With a view to develop C&D waste management in Libya. Based on the literature reviewed, there are a number of strategy “instruments” that can be adopted to further SC&DWM (as discussed in Chapter 2). However, the implementation of SC&DWM challenges different barriers in different contexts, which in this case pertain to the Libyan society and construction and waste management sector. Therefore, to facilitate choosing the right steps for the final framework, it becomes necessary to identify these strategies and barriers may hinder them based on adequate empirical evidence.

4.14.3 Negative Impacts

Despite the benefits of strategies toward SC&DWM reported in the literature, a number of studies (Wrap, 2007; Coelho and Brito, 2013) suggest that the application of C&D waste management techniques may result in some negative impacts. Therefore, this should be addressed by other strategies to overcome these negative impacts.

4.14.4 Complementary Strategies for Addressing the Challenges

There are diverse methods for overcoming the barriers to C&D waste management. If the existing strategies reported in literature are inadequate to the barriers in the Libyan context or any negative impact result of the implementation, exploring other strategies becomes necessary to address the barriers.

4.14.5 Outputs

Outputs are unmistakable services and goods that the venture generates. The outputs can be delivered at an early stage in the lifetime of the venture (e.g.

publication is an outcome of research, along with dissemination in reports, articles, policy briefs, meetings, seminars, workshops and other events and networks). Most investigation outputs have a tendency to surface at the completion of the venture or sometime after it has been completed, requiring long-term follow-up (Pasanen and Shaxson, 2016).

4.14.6 Outcomes

According to the World Bank (2015), outcomes and impacts are the fundamental focal point of an outcomes framework; venture inputs and application procedure are generally not emphasised, despite the fact that outputs are regularly noted. Based on the literature, there are positive outcomes to be accrued by implementing SC&DWM, such as providing new job opportunities, economic benefits, increasing reuse, recycling and recovery rate, reducing the quantities of waste generation, reducing the area of waste landfill. It also has some positive impacts such as reducing negative environmental impacts, and maintaining health, wellbeing and general appearance. Figure (4.10) shows the main steps of conceptual framework for sustainable management for C&D waste resulting from both conflict and normal construction activities.

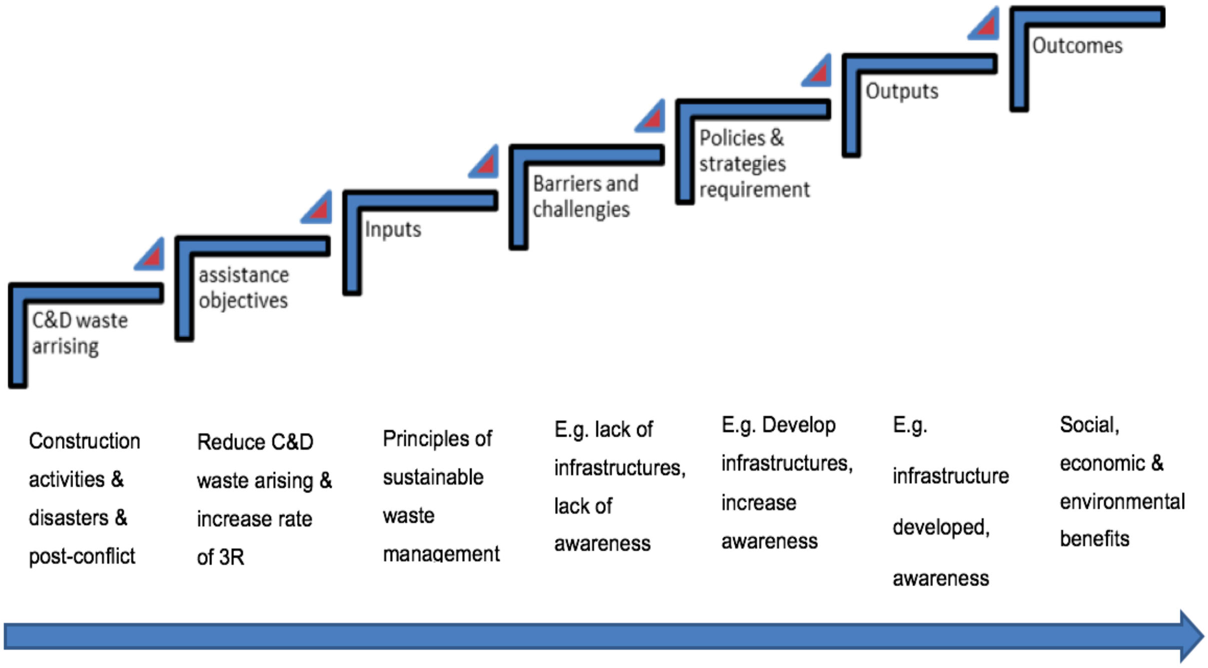


Figure 4-10: Conceptual framework for SC&DWM in Libya (Author)

4.15 Summary

The development of the conceptual framework was based on reviewing literature on C&D waste management globally (Chapter 2), as well as SWM in Libya (Chapter 3), and desktop review of PC/C&D waste management. The findings of the pilot study on barriers affecting sustainable management for C&D and PC waste have also been considered in this chapter. The literature indicates several strategies for SC&DWM can enable realisation of the benefits of the principles of SC&DWM in Libya. The main aim of implementing these principles is to divert C&D waste from sending to landfill and increasing rate of 3R, but there are numerous barriers that may hinder the adoption of SC&DWM as well as implementation issues that need to be considered. As found in Chapter 3, there is a lack in SWM in general and C&D waste in particular in Libya, despite increasing C&D waste generation, particularly since the 2011 conflict. PCW is an extraordinary waste type, associated with the exacerbation of general C&D waste generation and particular chemical hazards. Since most PCW is itself C&D waste, it is possible to create a framework to include both, taking into account some particulars with regard to the management of the former. Therefore, this chapter has developed a conceptual framework to deal with this emergency circumstance of PC and normal C&D waste management generated in order to fully address the research aim and associated objectives. The next chapter presents methodology adopted to obtain the desired results.

5 METHODOLOGY

5.1 Introduction

This chapter outlines the research design and methodology adopted for achieving the aim and objectives of this study. A mixed research method was adopted whereby the qualitative strand consolidates the quantitative one (Creswell, 2009). It first presents the justification for adoption of quantitative and qualitative research approaches, and the reasons behind merging them.

The chapter is organised in sections covering the research approach; literature review; types of research approach; questionnaire design; interviews (focus group discussion); data analysis and validation of the research findings.

5.2 Research Approach

Research is a technical procedure of gathering and analysing data about phenomena of interest (Pole and Lampard, 2002; Kanellis and Papadopoulos, 2009). Research includes outlining and redefining issues, proposing hypothesis or putting forward solutions; gathering, arranging and assessing data, making deductions and ultimately attaining conclusions and additional testing (Singh, 2006). According to Creswell (2009), there are three fundamental research paradigms in social science research: quantitative approach, qualitative approach and mixed methods. Each paradigm has ontological, epistemological and methodological assumptions. Ontology concerns the assumption of reality (Creswell, 1994), while epistemology essentially concerns the theory of knowledge embedded in the theoretical perspective in terms of objectivism and subjectivism, etc. while inform actual tools used in data collection, for example survey research, ethnography and experimental research etc. (Creswell, 2003).

Figure (5.1) shows the research onion, which classifies particular theories, philosophical viewpoints, approaches, strategies, choices, time horizons, techniques and procedures. For example, philosophical viewpoints can be based on the researcher’s ontological assumptions about reality, which determine the corresponding epistemological (i.e. philosophical) stance adopted by the research. Clearly this research is premised on a positivist ontology concerning volumes of material in the real world (i.e. C&D waste), but it also includes interpretive aspects relating to subjective human perceptions and opinions about the researched phenomena (i.e. the management of C&D waste), which determined the methodological strategy and methods chosen to address the research question. Consequently, the technique for data collection and analysis can be identified.

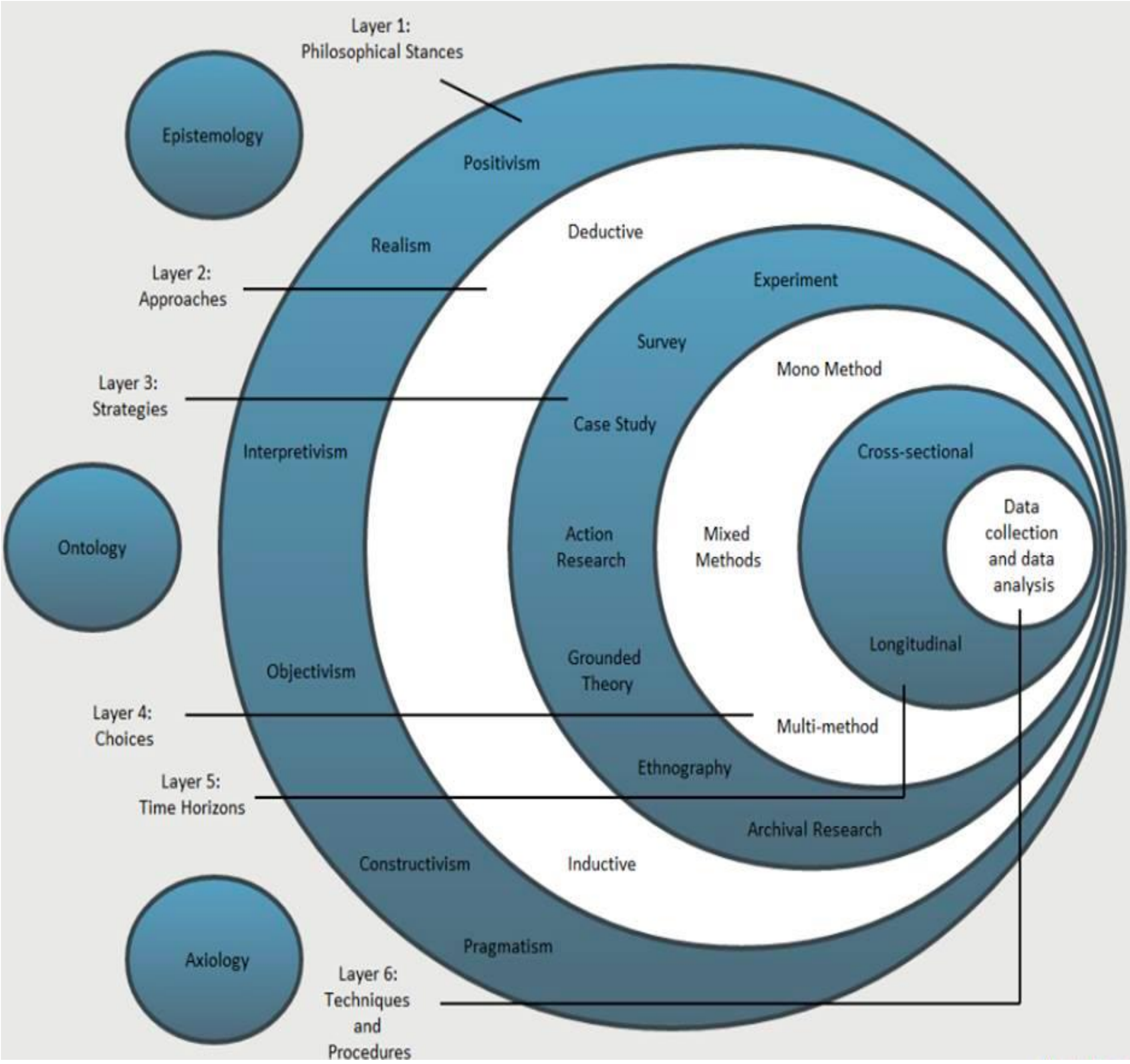


Figure 5-1: Research onion
(Saunders et al. 2009)

This research uses multiple methods for data collection and analysis, as the nature of the data required to address the research questions are diverse. Obtaining sufficient amount from different sources of information certainly helps understand the problem and in order to find appropriate solutions. Consequently, desktop study, pilot study, questionnaire survey, focus group interviews and observation were used.

Some of these data are mixed; some are quantitative (deductive) while others are qualitative (inductive). Since the research aim is to develop a framework for sustainable construction waste management in Libya, as quantitative data always plays vital role in developing a policy (Finch, 1986; Civil Service, 2014). However, quantitative researchers are starting to admit a role for qualitative research in policy and evaluation studies (Cronbach,1982 cited by Herriott and Firestone,1983; Smit, 2003), thus, the proper balance of qualitative and quantitative methods should be considered (Smith and Louis, 1982). Therefore, mixed research approach was expedient to this research. This helps offset the deficiencies of each individual approach.

For example, in quantitative study, researchers are unengaged with their subject, and in some circumstances they may have no contact with participants at all (Clark and Creswell, 2014). Indeed, the lack of engagement with participants is desirably in quantitative study, as the researcher is to be an impartial and objective observer.

Conversely, qualitative study seeks close partnership with the participants being investigated (Bryman, 2008). Table (5.1) attempts to draw out the chief contrasting features. Indeed, the research paradigm for the study is predominantly positivist (quantitative), which shows that the logic of the research is predominantly deductive.

Table 5-1: Some common contrasts between quantitative and qualitative research

Quantitative	Qualitative
Number	Words
Point of view of researcher	Point of view of participants
Researcher distant	Researcher close
Static	Process
Structured	Unstructured
Generalisation	Contextual understanding
Hard, reliable data	Rich, deep data
Macro	Micro
Behaviour	Meaning
Artificial setting	Natural setting

In this research, the quantitative approach (questionnaire surveys) was used to investigate the current situation, the nature of the barriers that effects adoption of SC&DWM in the Libya and the main key strategies to overcome. On other hand, the qualitative approach was used for rich observational data and FGD to produce additional beneficial supporting data, particularly from experts, in order to reinforce quantitative clues. Figure (5.2) illustrates the chief rationale of adopting mixed research approaches.

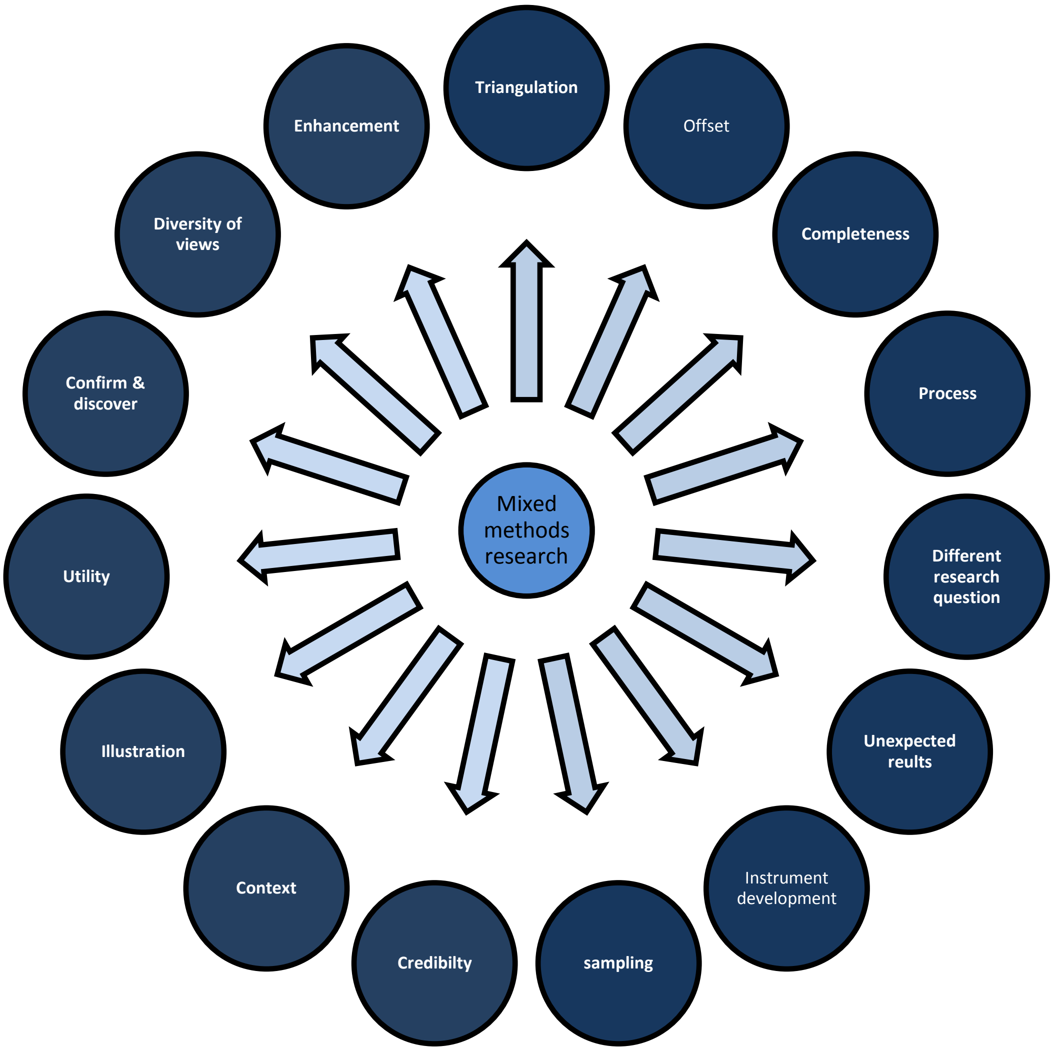


Figure 5-2: Reasons behind adopting mixed research approaches (adopted from Bryman, 2008)

This method is analogous with many different scale studies in the field of environment and waste management research (Begum, 2009; Ezeah, 2010; Meding, 2013; Asudevan, 2015; Abarca-Guerrero *et al.* 2017). Table (5.2) shows the trend of research methods in publications in C&D waste management.

Table 5-2: Trend of research methods adopted C&D waste management

Research approach	*Number of papers*	*Percentage %*
Case study	34	39.1
Survey	30	34.5
Review	16	18.4
Experiment	7	8.0

Source: Yuan and Shen (2011)

5.3 Data Collection and Analysis

Deciding the best methods as well as the phases to be utilised in data collection and analysis one of the most vital aspects in any research study. Gill and Johnson (2002) and Creswell (2003) state that nature of data, research subject, research question aims and objectives and kind of resources obtainable significantly affect the identification of the research design. Therefore, in this study the kinds of data mentioned determine what type of tools that were used. Figure (5.3) identifies the synergy between two main keys of this research to give a concrete foundation for this study.

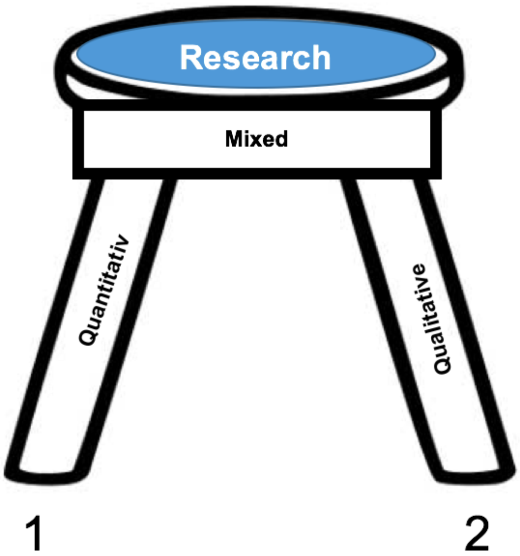


Figure 5-3: Three main types of data

Therefore, in the event that the right kind of methods are utilised for the study, the researcher ought to have the capacity to persuade other individuals that the decisions have some validity. The new evidence produced must also be worthy (Walliman, 2011). Figure (5.4) summarises the steps of this research design.

5.4 Literature Review

Literature review is a critical phase of any research. A literature review usually has two main purposes. First, it helps to improve and magnify the research knowledge, and second, it increases the knowledge and understanding of researcher to become relevant and updating with latest information about the topic (Hair, 2015). A comprehensive literature survey of official reports by government agencies, textbooks, journal articles, conference proceedings and electronic databases was undertaken, searching for key words relating to C&D waste management.

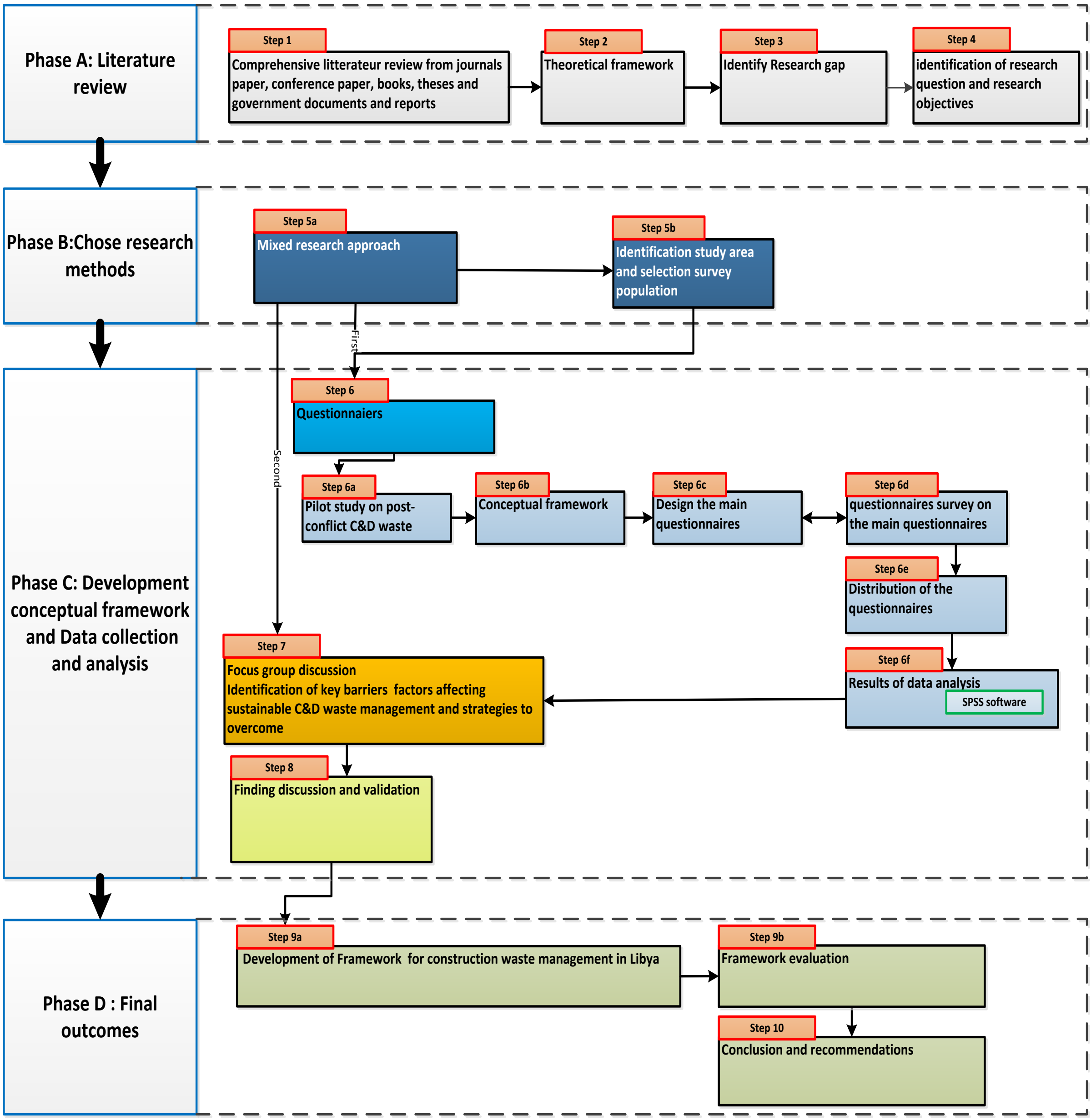


Figure 5-4: Research design and data collection

5.5 Types of Research Approach

In any type of research, counting things or talking with people is usually required (MacDonald and Headlam, 2009). Consequently, it is beneficial to think of different opportunities for data gathering in any study, as well as to form these methods by their degree of predetermined nature, their utilisation of closed-ended versus open-ended questioning, and their focus for numeric versus non-numeric data analysis

(Creswell, 2003). There are three major elements that goes into a research approach is the specific methods of data collection and analysis, as shown in Table (5.3).

Table 5-3: Quantitative, qualitative and mixed methods procedures

Quantitative Research Methods	Qualitative Research Methods	Mixed Research Methods
Predetermined Instrument based questions Performance data, attitude data, observational data, and census data Statistical analysis	Emerging methods, open-ended questions; interview, observational, documentary and audiovisual data; text and image analysis	Both predetermined and emerging Open- and closed-ended questions Multiple forms of data drawing on all possibilities Statistical and textual analysis

Source: Creswell (2003)

Quantitative approach is concerned with trying to quantify things. It asks questions such as 'how long', 'how many' or 'the degree to which'. Quantitative methods look to quantify data and generalise results from a sample of the population of interest. They may look to measure the incidence of various views and opinions in a chosen sample (MacDonald and Headlam, 2009). However, quantitative research is good at providing information in breadth, from a large number of units, but when we want to explore a problem or concept in depth, qualitative methods can be too (Creswell, 2009). To really get under the skin of a phenomenon, we need to use ethnographic methods, interviews, in-depth case studies and other qualitative techniques (Muijs, 2004).

Mixture of qualitative and quantitative techniques have been used broadly in social science research (Newrnan and Benz, 1998), and mixed methods research has become a distinct approach in its own right (Greene *et al.* 1989; Creswell, 2003, 2013; Tashakkori and Teddlie, 2003; Weinreich, 2006; Creswell and Plano Clark, 2007; Teddlie and Tashakkori, 2009). According to Cooper and Schindler (2008), many researchers trust that both approaches supplement rather than oppose each other, and quantitative research may make up for the shortcomings of qualitative research and vice-versa. However, there are potential problems in applying either or both approaches correctly in mixed methods research (Weinreich, 2006). This type of approach requires research aptitude in both sorts of strategies, utilising various methodologies in laborious, time-consuming and potentially costly concurrent, sequential and transformational mixed method designs (Brewer and Hunter 1989, 2006; Scrimshaw 1990; Creswell, 2009; Small, 2011). Figure (5.5) summarises the main kinds of mixed method research approaches.

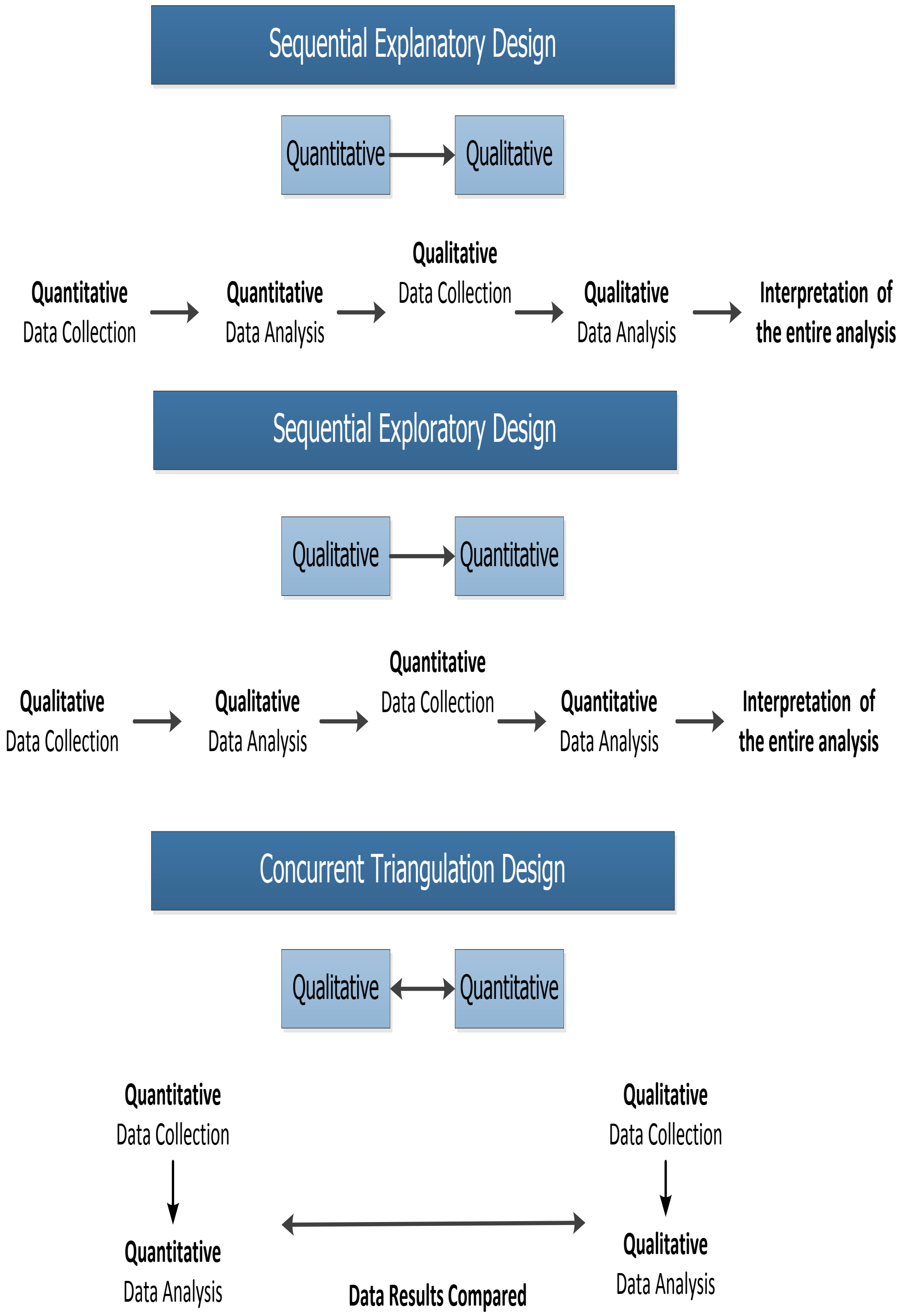


Figure 5-5: Main type of mixed research approach (Creswell, 2003)

5.6 Design of Survey Questionnaires

The questionnaire is the tool of communication between the interviewer (often though not always the lead researcher) and the subject (Oppenheim, 1992). A questionnaire is an instrument of discussion between two individuals, even if administered remotely (Brace, 2004). It is essential that the questionnaire outline addresses the requirements of the research, empowering the analyst to answer the targets of the study (Burgess, 2001). Data should be gathered accurately, choosing appropriate participants and answering clear questions to enable participants to deliver required data (Brace, 2004). The general public, individual experts and organisations (people working in construction companies such as architects, civil engineers, and contractors), people working in the waste management sector (public and private), policy makers and people interested in waste management (e.g. authors, academics, and environmentalists) are the principal unit of analysis in this research, with consideration of barriers affecting sustainable SC&DWM in Libya and strategies to overcome them. Due to complex nature of the data requirement of the research and expected level of information, knowledge and background of people involved in C&D waste management, this study applied three individual questionnaires with four different groups.

One questionnaire was designed for the general public with closed responses and limited choices. Since a large proportion of the general public is engaged in construction work, which usually includes all kind of construction activities such as construction, renovation and demolition works, this study decided to consider this group in this survey (see Chapter 3, Section 3.2.3.1). The survey for this group was distributed to most residents within the selected cities. This shows that everybody aged 18 and above was eligible for inclusion in the study.

A second questionnaire was for people involved in construction sector and waste management (e.g. architects, civil engineers, contractors, sub-contractors, developer and recyclers etc.); one for policy makers in the sector of the environment and waste management (e.g. Ministry of Environment, Ministry of Housing, Utilities, General Service Company, Environment Committee in the Libyan Parliament and Environmental Protection Agency). The third questionnaire was for Libyan experts on the environment and waste management itself. Table (5.4) shows the categories of policy makers and expert participants groups who participated in this survey. These groups of participants were chosen according to the recommendations of Park and Tucker (2016).

Table 5-4: Category of policy makers and expert participants groups

	Group	Category	Number of participants
1	Policy makers	Municipality councils	**10**
		Environment committee in Libya parliament	**3**
		Environment general authority	**8**
		Ministry of local government	**4**
2	Experts	General service companies	**35**
		Waste management private companies	**17**
		Construction companies	**46**
		Consultant in construction work	**13**
3	Group of experts interested in environment and waste management (GPiE&WM)	Academic, researcher, environmentalist	**34**

All three questionnaires are essentially similar in structure, but those for people involved in the construction sector and waste management, policy makers and the Libyan experts included particular questions, such as those concerning current C&D waste management in their organisations and the adoption and transfer of strategies successful in developed countries for SC&DWM in Libya. These questions were used to obtain the most contextually rich information from each group in addition to understanding their background and institution in depth. More open-ended questions were also used for experts to allow them to contribute freely in their own words, based on their own experiences and perceptions. In gathering data to identify the existing situation and major barriers to adopting sustainable management practices in Libya, as per research objective 3, the questionnaire design relied on the literature review, pilot study on PC/C&D waste and conceptual framework. The final questionnaire designs were therefore significantly conditioned by the conceptual framework, which provided a robust basis for archiving the literature review findings relative to the final questionnaire designs.

The justifications behind designing, organising and choosing the questions in such a way include: (i) achieving the study objectives; and (ii) collecting data for the critical area of C&D waste management in Libya, for which there is currently no previous information. To augment the rate of response, these questionnaires are designed to achieve research goals together with an attractive layout and as concisely as possible (Dillman, 1983; De Vaus, 2002). Figure (5.6) shows the steps of main questionnaires design.

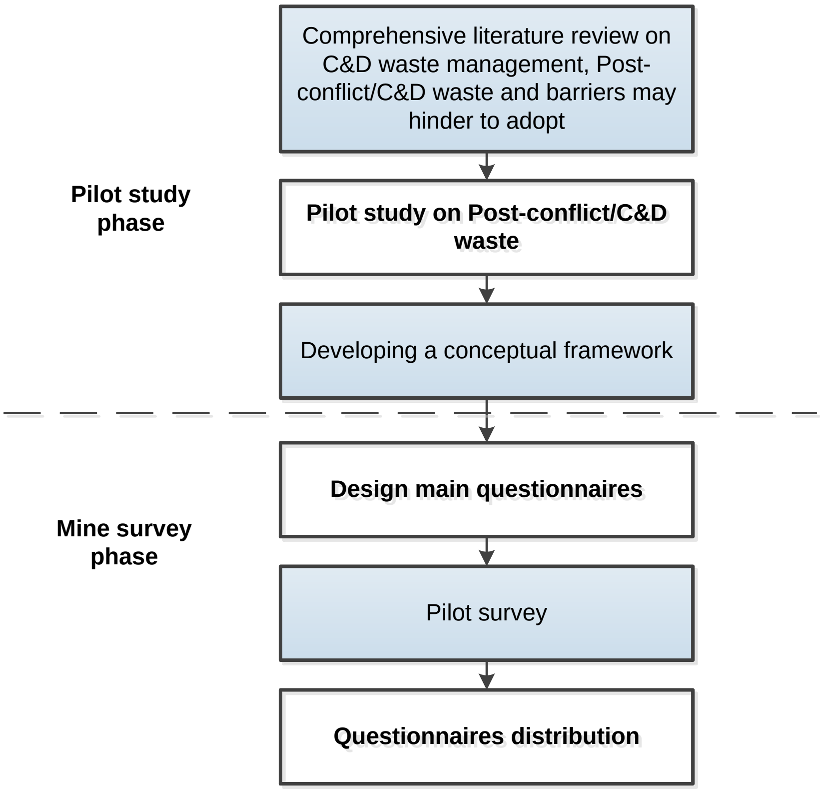


Figure 5-6: Processes of the main questionnaires design

5.6.1 Ethical Considerations

Ethics is of absolute and fundamental importance in academic research, particularly when involving human participants. In research of human communities, including individuals, organisations and businesses, the rights of participants must be respected and assured during all stages of data protection, handling and reporting (Polonsky and Waller, 2010). The interaction with participants can be in different ways, including interviews, focus groups discussion, individual interviews, questionnaire surveys and also observation. Researchers are obliged to protect participants from any kind of harm, including coercive participation (Neuman, 2006; Bryman, 2008; Bashir, 2013). Previously, to communicate with responders, ethical approval was obtained from the Life Sciences Ethics Committee Faculty of Science and Engineering, University of Wolverhampton, on 08 July 2016 (see appendix 4).

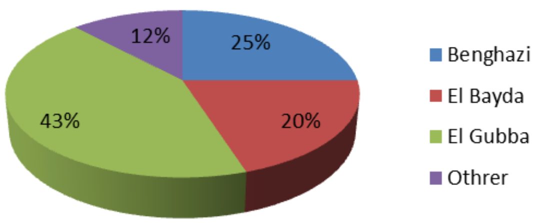
5.6.2 Pilot Survey

On a basic level, practically anything related to a social survey can and ought to be piloted, including the detailed technique of designing the sample to the kind of paper the participants will use to fill in (Oppenheim, 1992). There are a number of advantages behind adopting a pilot survey, including determining answers to the following questions:

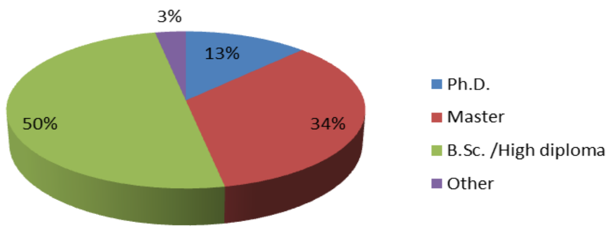
1. Do participants comprehend the questions?
2. Are the questions well designed?
3. Does the questionnaire include any vague questions?
4. Is it easy for participants to respond to the questions?
5. Are the answer symbols provided (if applicable) adequate?
6. Do the questions preserve the attention of participants throughout?
7. Is the flow, order and route in the questionnaire cohesive and appropriate?
8. How long do participants need to complete the questionnaire?
9. Is the question and questionnaire of appropriate length?
10. Does the method of questionnaire distribution work?

Participants in pilot research ought to be as analogue as possible to those in the principle enquiry, and they may in fact be included in the final sample if appropriate to the particular methods applied. Generally, however the results of pilot testing are not included in final analysis, and the pilot test is mainly used to determine the appropriateness of the instrument to gather the necessary data to answer the research question (Oppenheim, 1992; Denscombe, 2007). Consequently, the questionnaires were translated into Arabic and the pilot survey was therefore conducted. Although the researcher understands and speaks both languages, to compensate for information lost due to translation a certified translator was consulted.

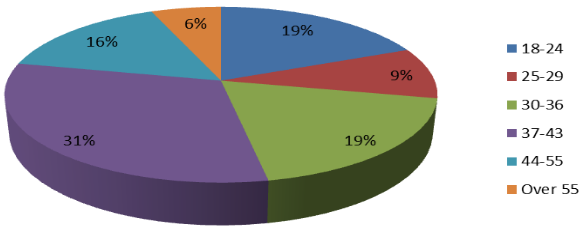
The questionnaire was piloted using Facebook. Hill (1998) recommended 10 to 30 participants for pilot questionnaires in survey research. To increase the rate of return for the pilot survey questionnaire, the questionnaire was sent to 90 randomly selected Libyan people (of whom the first 30 were chosen based on their city of residence, in Benghazi, El Bayda or El Gubba). The main reason to use social media (Facebook) was to access and contact to individuals in distant locations. However, online survey or using social media websites has potential limitations. The main limitation in this case concerned controlling for who took the surveys. To overcome this issue the questionnaire was sent to specific target groups based on their place of residence and age, according to their Facebook account. The reason behind using Facebook is because it is more popular and widely used in Libya than other social media platforms such as LinkedIn. A total of 30 responses were returned, representing a response rate of approximately 33%. Figure (5.7) illustrates categories responses to the pilot survey; 0.80 conventionally denotes a reasonable level of internal reliability, though many authors use a slightly lower figure. In the case of commitment to work scale devised by Westergaard *et al.* (1989) and Sekaran (2003), Cronbach's alpha is normally utilised to find internal reliability construct validity for similarity scales, with 0.60 deemed acceptable for exploratory purposes, 0.70 deemed sufficient for confirmatory purposes, and 0.80 considered very good for substantiating purposes (Garson, 2016). Cronbach's alpha is both a validity coefficient and a reliability coefficient. Based on the pilot survey responses (Section 6.2), the Cronbach's alpha is 0.819 (>0.7). This shows that the questionnaire is reliable and harmonious.



Distribution of respondents according to city



Level of education



Age of respondents

Figure 5-7: Categories of responses to the pilot survey

5.6.3 Sampling Strategies

Sampling strategies are the methods of gathering respondents anticipated to exemplify and generally represent the target population (Denscombe, 2010). A population could be an objects, organisations, people or even events. Inside this population, there will perhaps be one particular set of concern to the research, such as objective small companies, or all high schools in a particular region (Dawson, 2002). This picked denomination is the sampling frame, from which the sample is picked. Figure (5.8) displays these processes.

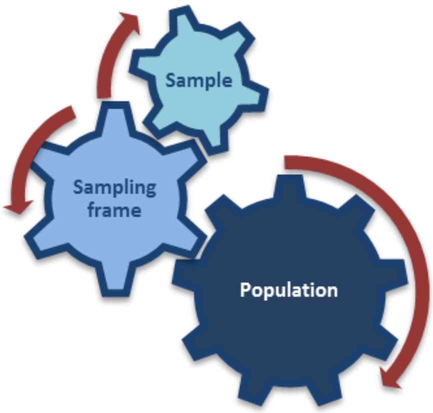


Figure 5-8: Processes of sample selection (Dawson, 2002)

According to Vonk (2007), there are basically two main groups of sampling strategies, probability and non-probability sampling strategies, based on the population size. Probability sampling was used in this study. In respect of how to distribute experts' questionnaire, the survey was carried out in ministries, companies and organisations related to or involved in waste management or construction activities. In this study, the decision was made to use a simple random sample that will give equal opportunities for construction companies to participate in this survey according to the lists obtained from official authorities (e.g. municipal councils). Based on the lists provided of 34 companies, 12 companies were selected randomly of whom 8 agreed to participate. However, characteristics of the companies were difficult to define due the lack of data about number of employees and the capital of companies. For ministries and other organisations related to waste management convenience sampling was used.

The questionnaires were distributed based on consent letters received (see appendix 2). Therefore, in this questionnaire survey the decision was made to select participants based on their experiences and knowledge in waste management. The questionnaire was also distributed to Libyan experts interested on environment and waste management during the conference Evaluation of Environmental and Biological Contamination, held between 27-28 August 2016 at the University of Benghazi, Libya. Dawson (2002) noted that in quantitative study, it is supposed that if the sample is selected neatly by means of the precise process, it is then likely that the outcomes can be generalised for the entire study population.

5.6.4 Sample Size Determination

Sample size determination is an important part of any research. The probable size appropriate to the study aims at the design phase depends on a subjective decision of certain elements and occasionally crude approximation of others (Whitley and Ball, 2002). A reasonable sample size for questionnaires distributed to a public group can be calculated using the following equations (Al Rifa'y, 1998; Ayyub and Mccuen, 2003).

$$ss = \frac{z^2\ x\ (p)\ \mathrm{x}\ (1-p)}{c^2} \qquad \textbf{Eq. 4.1}$$

Where:
SS = sample size,
Z = Z value (e.g. 1.96 for 95% confidence level)
p = percentage picking a choice, expressed as decimal (0.5 used for sample size needed),
C = confidence interval, expressed as decimal (e.g., 0.05 = ±5)
Thus:

$$ss = \frac{(1.96)^2\ x\ (0.5)\ \mathrm{x}\ (1-0.5)}{(0.05)^2} = \qquad \textbf{Eq. 4.2}$$

Therefore, based on these equations and the population of each city, the appropriate sample sizes for Benghazi, El-Bayda and El Gubba are: 384, 384, and 380, respectively.

5.6.5 Questionnaire Administration

Questionnaires can be administered in several ways, including on-line, post, e-mail attachment, or face-to-face for interactive completion (Burgess, 2001). Research survey responses rates are commonly about 20%, which implies that one must disseminate five times the number of questionnaires required for data analysis; according to Creswell (2003), for most research a response rate of between 20-30% is acceptable even in the situation of developed nations, with appropriate postal infrastructure, but in the case of Libya there is no functioning postal system due to a lack of investment in the appropriate infrastructure and the on-going conflict. It was decided to administer the survey face-to-face. This also enhances the rate of return since the questionnaires will be delivered directly by hand to the respondents and collected back upon completion.

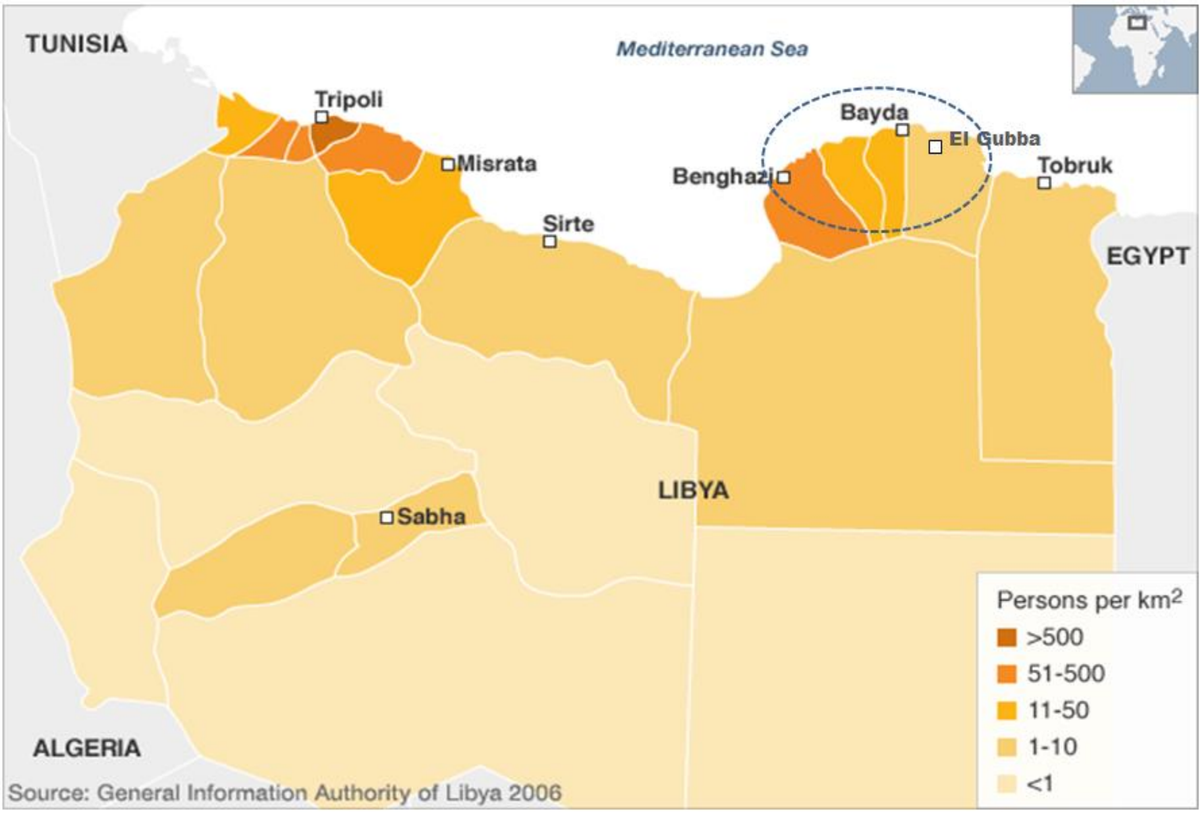


Figure 5-9: Libyan map and population density
http://www.bbc.co.uk/news/world-africa-12572593

Three cities were selected to distribute the questionnaires: Benghazi, El-Bayda and El Gubba, the rationale for selecting these cities (see Section 1.5). Electronic versions of the questionnaires are available for using where necessary. The questionnaire was distributed in public or community gatherings, after dividing cities selected into several areas to get equal numbers of participants in the sampling area. Using this method, the researcher delivered a presentation (Figure 5.10) to eight assistants to assist in the administration of the questionnaires to randomly selected public participants between August and September, 2016.

Figure 5-10: Participants at questionnaire administration

At the end of the exercise, a total of 974 questionnaires were returned, an equivalent to 81.1% return rate from 1200 public questionnaires were distributed. For the other groups expert group, policy makers and GPiE&WM 200, 50 and 50, with return rate of 55.5%, 50% and 68% respectively. Table (5.5) is an outline of respondents' groups in the survey and Table (5.6) shows the residency of respondents.

Table 5-5: Respondents' groups

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Public	974	85.1	85.1	85.1
	Expert group	111	9.7	9.7	94.8
	Policy maker	25	2.2	2.2	97.0
	GPiE&WM	34	3.0	3.0	100.0
	Total	1144	100.0	100.0	

Table 5-6: Respondents' groups by place of residence

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	El Gubba	376	32.9	32.9	32.9
	El Bayda	331	28.9	28.9	61.8
	Benghazi	418	36.5	36.5	98.3
	Other	19	1.7	1.7	100.0
	Total	1144	100.0	100.0	

5.7 Fieldwork Observation

Research questions are addressed by both qualitative and quantitative researchers using empirical observations (Johnson and Onwuegbuzie, 2004). Observational method is a structure utilised by qualitative investigators whereby they record information about current situations observed (Creswell, 2009). According to Rugg and Petre (2007), the unique purpose of observation is to demonstrate something without the liquidation impact of language. Different things being equivalent, one can perceive how something really happens, counting a wide range of things that are so well known to respondents that they could never consider specifying them in an interview. In this study, observation (e.g. visiting landfill sites and recycling plants) was used to further understand the situation on ground and to strengthen the quantitative evidence.

5.8 Focus Group

In qualitative interviews, the investigator can conduct face-to-face, telephone or focus group discussion (FGD) interviews, generally with six to eight interviewees in each set. In general, these types of interviews contain unstructured questions, particularly open-ended questions (Creswell, 2009).

Fontana and Frey (2005) noted that the FGD or interview can be a capable instrument for picking up data not easily reached in personal interviews, therefore communications between set individuals arouse recollections and thoughts that would not have surfaced in a separate interview (Fontana and Frey, 2005). Thus, group interviews can be particularly convenient for making manifest the vision, understanding and stimulus of the participants (Punch, 1998). The focus group is a kind of group interview which includes different participants, with a common experience of the research phenomena, and a moderator (Bryman, 2008). The reasons behind conducting FGD are discussed in Chapter 7, Section 7.2.3.

There are some potential pitfalls inherent in the focus group interview, comprising: (i) some participants of the set may predominate the discussion; (ii) some participants may be disinclined to participate in the discussion; (iii) groupthink sometimes causes limits on the information being sought (Fontana and Frey, 2005). FGD approach has been used successfully in many studies on waste management (e.g. Mbeng, 2009; Refsgaard and Magnussen, 2009; Ezeah, 2010; Abarca-Guerrero *et al.* 2017).

5.8.1 Focus Group Design

Smaller sets are prescribed when participants are prone to have a great deal to say on the subject, when the subject is questionable or complex, and when participants' individual experiences are pertinent (Morgan, 1998a; Bryman, 2008). The number of focus group members should be increased if the researcher feels that the kinds and range of views are likely to be affected by socio-demographic factors, or the analysis is difficult and complex (Schlesinger *et al.* 1992).

5.8.2 Selection of FGD Participants

Anybody for whom the subject is pertinent can be a suitable participant (for more detail, see Section 7.2.2). For some research subjects there is no need for particular types of participants, thus they have few exclusion criteria for focus group members. However, most focus group studies apply more profiling in the selection of participants likely to share more valuable data (Bryman, 2008). Consequently, FGD was used to produce additional beneficial supporting data, particularly from experts, in order to reinforce the quantitative data already gathered. The nature of the questions was basically to clarify and probe areas of ambiguity or interest that emerged from the quantitative strand and did not differ remarkably from the questions originally asked in the questionnaires.

5.9 Data Analysis

Descriptive investigation design is utilised and Statistical Package for the Social Sciences (SPSS, version 20.0) was used to analyse the data in terms of mean scores, standard deviation frequency percentages and variation. Qualitative content analysis was used to analyse the qualitative data from the FGD and open-ended questions in the survey. Criteria as credibility, transferability, dependability and conformability are the ways to vindicating, and guaranteeing that trustworthiness exists in the qualitative data research (Shenton, 2004 and Veal, 2011).

5.9.1 Descriptive Statistical Analysis

According to Denscombe (2007), the aim of descriptive statistics is to find out the designs and processes of sample data. It is applied to reach outline figures which characterise the allocation of the sample data. The way in which variables are administered in the questionnaire is univariate, which implies that the analysis technique needed is frequency distribution (De Vaus, 2002).

5.9.2 Chi–Square Test

According to Denscombe (2010), Chi-square test is applied to examine if there is an association between two groups of variables. According to Ankrah (2007), X^2 test is a non-parametric method that tabulates a variable into categories and calculates x^2 statistic to test the hypothesis that the observed frequencies do not vary from their expected values. The aim of applying X^2 is to test the variance between an actual sample and another hypothetical one. If the accounted value (χ^2) is smaller than the critical value (0.05), the null hypothesis (H_0) is accepted as there is no statistically significant relationship between variables, while if the accounted value is bigger or even equal to the critical value, the null hypothesis is rejected, which can also be known as there is no relationship between variables. Mathematically, this relationship can be represented as equation below relationship between variables.

$$\sum \frac{(O-E)^2}{E} \qquad \textbf{Eq. 4.3}$$

Where: O = observed values

E = expected values

$\chi 2$= Chi-squared

$\sum$ = summation

5.9.3 Multivariate Analysis of Variance (MANOVA)

Multivariate analysis of variance (MANOVA) is parametric test. This is simply an ANOVA with several dependent variables. ANOVA is the most commonly used statistical test to compare sets of cases for variances in their means. ANOVA is a strategy for testing at the same time whether two or more populace means are altogether diverse (Tabachnick and Fidell, 2001), whereas MANOVA tests for the difference in two or more vectors of means (French, 2002).

5.9.4 Content Analysis

Content analysis is a way of interpreting textual data by the systematic classification procedure of coding and identifying themes, which emerge from the analysis of narrative responses, for example those from open-ended survey questions, interviews, focus groups and observations (Kondracki and Wellman, 2002).

5.10 Validation of Research Findings and Framework Evaluation

In mixed methods research validation, the researcher starts validating the findings from the quantitative measures and compares the validity of the qualitative results. In mixed research approach, further validity attention emerges. The precision of the overall results might be affected because the investigator does not take into account using various samples for each stage of the research. This reduces the significance of one stage structure on the other. Also, an insufficient sample size can be challenged on whichever quantitative aspect of the research or the qualitative aspect. Planning a worthy mixed methods study is influenced by diverse internal or external factors (Seliger and Shohamy, 1989; Creswell, 2014). To overcome these influences, there are two main aspects to validate research findings, as shown in Figure (5.11). External (respondent) validation was used to evaluate and confirm the transferability and workability of the proposed framework for SC&DWM.

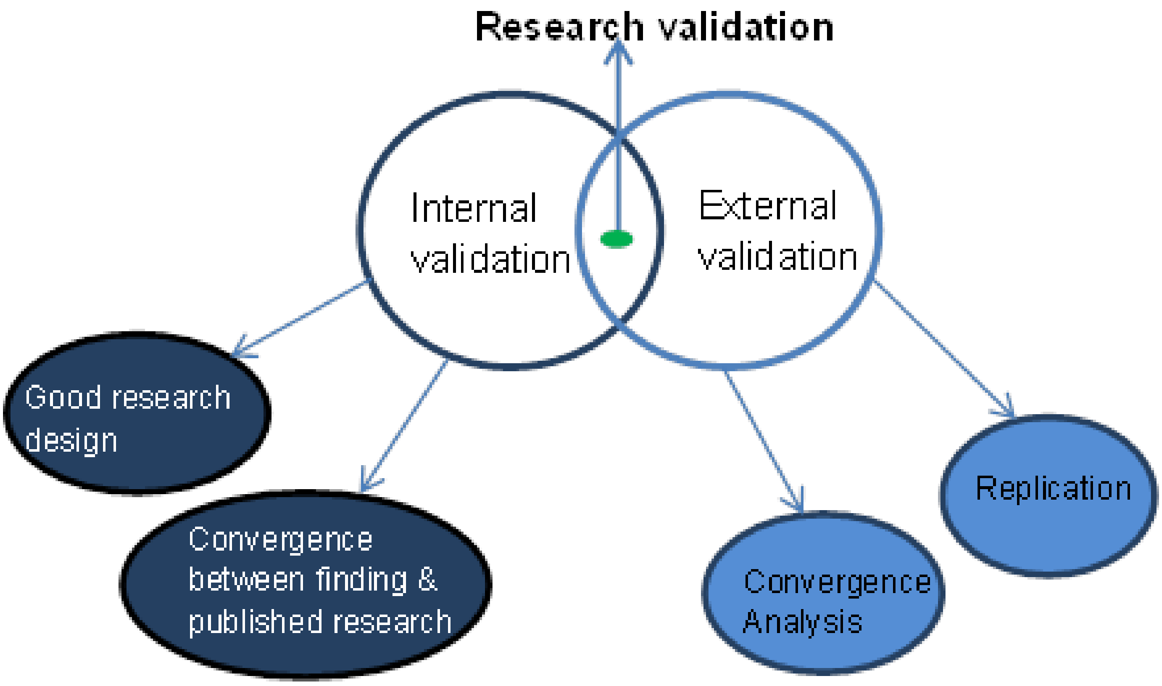


Figure 5-11: Common types of research validation methods

5.11 Summary

This chapter has reviewed and presented the methodology carried out for the achievement of the aim and objectives of this research. This research has adopted mixed methods approach employing quantitative and research qualitative methods. The research approaches and sampling techniques have been exhibited and the application of each methodology and strategy was sufficiently vindicated. In order to investigate the questionnaire is reliable and harmonious, pilot survey was carried to achieve research associated objectives. SPSS 20.0 was utilised for analysing the collected data. Furthermore, participants were selected from the respondents to the main questionnaire survey to participate in the FGD. This stage was to supplement, the other methods earlier and to scout in more details issues that emerge resulting of applying the questionnaire survey. Content analysis was utilised to analyse the qualitative data from the FGD and open ended questions. Having discussed the methodology employing the following chapter presents the quantitative study findings.

6 QUESTIONNAIRE SURVEY RESULTS

6.1 Introduction

This chapter displays the results of pilot survey and the main questionnaire survey administered between August and September 2016 to gather data on features of C&D waste management in Benghazi, El Bayda and El Gubba. The chapter presents descriptive and inferential statistical results, the results obtained for the analysis of nominal and ordinal data, analysis of barriers to adopting SC&DWM and the main strategies to overcome, the analysis approach (concerning the improvement of C&D waste management), analysis of the outcome of implementing SC&DWM in Libya, and the conclusion and recommendations.

6.2 Pilot Survey Results

For this pilot survey 90 questionnaires were sent and 30 participants responded (see Section 5.6.2 for more details). As shown in Figure (6.1), nearly 30% of respondents said the collection and transfer of their C&D waste is undertaken by the project owner, while about 27% each cited contractors or public service companies, which reflects the lack of clarity in determining responsibility for C&D waste management in Libya.

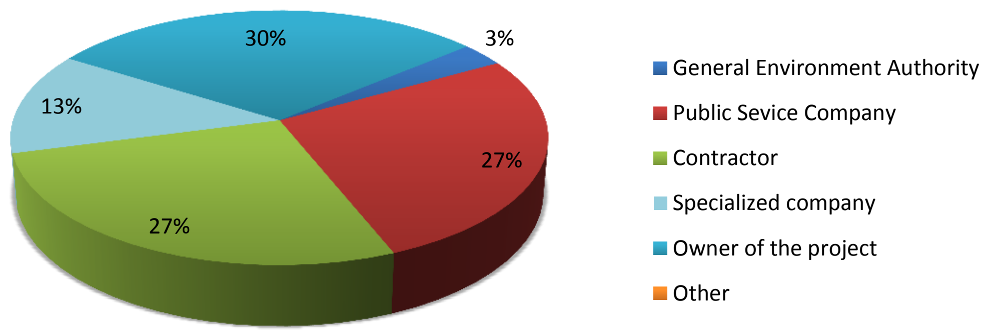


Figure 6-1: Distribution of respondents according on responsibility for collection and transfer of C&D waste in Libya

Figure (6.2) shows that approximately 44% of respondents said people dump construction waste in unauthorised places because there is no penalty to stop people, and companies landfill their C&D waste in such areas (typically open area and desert). As shown in Figure (6.3), about 44% respondents said private firms are best equipped to manage construction waste in the country, with others preferring joint ventures with the government or private efforts by individual firms.

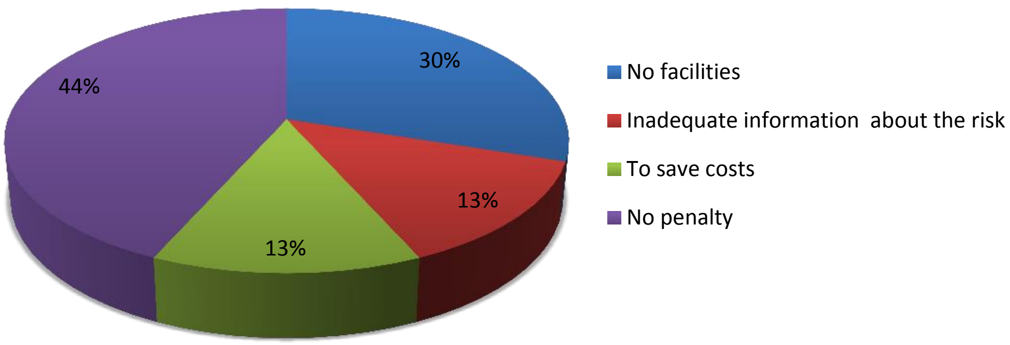


Figure 6-2: Distribution of causes dumping C&D waste in unauthorised places

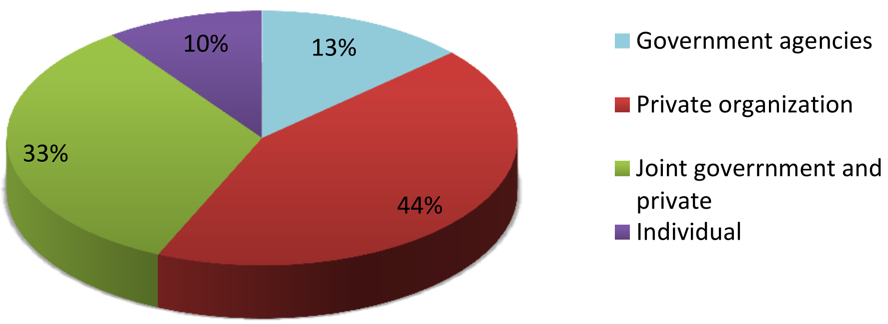


Figure 6-3: Distribution of respondents according best equipped to manage the construction waste problem in Libya

Figure (6.4) shows that roughly 74% of respondents stated that C&D waste recycling is the environmentally friendly way to manage such waste waste in Libya, as opposed to about 13% each who said waste minimisation and landfill. On the other hand, no respondents mentioned energy generation, perhaps due to the lack of background on this topic or a lack of clarity in the question, or the ubiquitous belief that as Libya is rich in oil it does not need alternative energy sources.

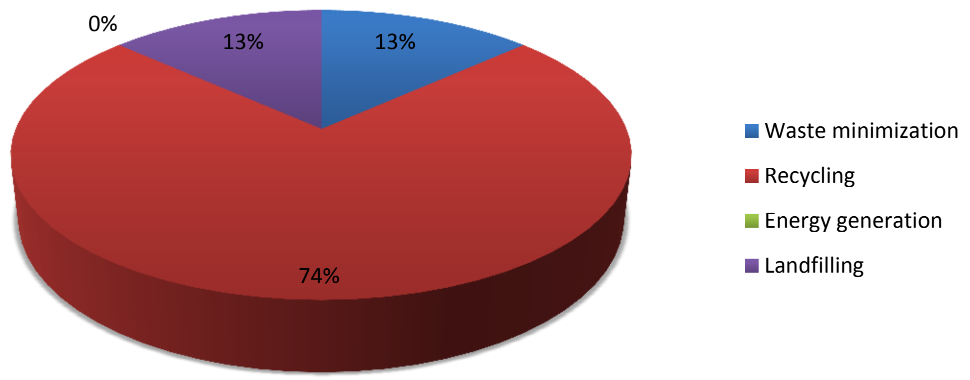


Figure 6-4: Distribution of respondents according to friendly way to manage C&D waste in Libya

Table (6.1) shows responses indicating how the listed barriers affect adopting sustainable C&D waste management in Libya utilizing a Likert-type scale ranging from 1 to 5, with an additional ‘not sure’ option. An assessment of 1 suggests the factor is a very low influence barrier whereas 5 suggests the factor is a very high influence barrier to adopting sustainable C&D waste management in the country. The majority of respondents mentioned that most of the barriers affect adopting sustainable C&D waste management in Libya pertain to low public education on construction waste management and a lack of facilities. Other significant barriers as recognised by respondents were on the matter of encouragement (e.g. financial incentives). There was low recognition of the factors different waste management services from one place to another (e.g. city, town, village etc.) and a lack of planning making construction waste collection difficult.

Respondents were asked to indicate how the approaches listed in Table (6.2) could improve C&D waste management in Libya, utilizing the same method as used in the assessment of barriers to adopting sustainable C&D waste management. In this question the 1-5 scale ranges from 1 ‘very low support’ to 5 ‘highly support’. Most of the suggestions listed achieved a high rate of agreement from respondents. More stringent enforcement of legislation and regulations for C&D waste was mentioned as the best suggestion to improve sustainable C&D waste management.

Table 6-1: Respondents' assessment of barriers effect adopting sustainable C&D waste management

No	Please indicate how the following barriers affect adopting construction waste management in Libya								
	A value of affecting / Barriers	1	2	3	4	5	Not Sure	Count	Percent
1	Waste policies lack clear strategies for action	0 00%	5 16.7%	4 13.3%	6 20%	12 40%	3 10%	30	100%
2	Laws regulating waste management are inadequate (lack of government Interventions)	1 3.3%	6 20%	4 13.3%	7 23.3%	8 26.7%	4 13.3%	30	100%
3	Construction waste management institutions are weak	2 6.7%	2 6.7%	4 13.3%	7 23.3%	14 46.7%	1 3.3%	30	100%
4	Unplanned aspects of the city make construction waste collection difficult	1 3.3%	7 23.3%	2 10%	8 40%	4 13.3%	2 6.7%	30	100%
5	Availability of dumping grounds discourages expensive investment in alternative disposal methods	3 10%	5 16.7%	2 6.7%	8 26.7%	11 36.7%	1 3.3	30	100%
6	Limited funds available are sometimes misused	3 10%	4 13.3%	3 10%	4 13.3%	12 40%	4 13.3%	30	100%
7	Public education on construction waste management is low	2 6.7%	3 10%	3 10%	5 16.7%	17 56.7%	0 00%	30	100%
8	Waste workers are poorly trained and poorly paid	2 6.6%	1 3.3%	6 20%	7 23.3%	9 30%	5 16.7%	30	100%
9	Operational equipment is obsolete and insufficient	4 13.3%	2 6.7%	4 13.3%	7 23.3%	8 26.7%	5 16.7%	30	100%
10	There is no tax to control construction waste disposal	3 10%	2 6.7%	3 10%	6 20%	13 43.3%	3 10%	30	100%
11	Types of material (e.g. produce unrecyclable materials)	4 13.3%	5 16.7%	5 16.7%	4 13.3%	11 36.7	1 3.3%	30	100%
12	Encouragement (e.g. financial incentives)	3 10%	4 13.3%	0 00%	4 13.3%	16 53.3%	3 10%	30	100%
13	Different waste management service from one place to another e.g. City, town, village	5 16.7%	2 6.7%	3 10%	4 13.3%	8 26.7%	7 23.3%	30	100%
14	Lack in the facilities of waste management	3 10%	3 10%	1 3.3%	3 10%	17 56.7%	3 10%	30	100%
15	The lack of reliable data base (e.g. quantity of construction and demolition waste)	2 6.7%	3 10%	3 10%	6 20%	14 46.7%	2 6.7%	30	100%
16	No review of waste management plans on a regular basis	2 6.7%	6 20%	2 6.7%	1 3.3	14 46.7%	5 16.7%	30	100%
17	Lack of interest from clients	1 3.3%	4 13.3%	2 6.7%	7 23.3%	11 36.7%	5 16.7%	30	100%
18	Lack of market competition	2 6.7%	5 16.7%	2 6.7%	4 13.3	16 53.3%	1 3.3%	30	100%
19	Attitude of some construction professional such as architects and engineers	3 10%	4 13.3%	4 13.3%	6 20%	10 33.3%	3 10%	30	100%
Count total		46	73	57	106	225	58		
Number of responses		30							

1 Very low influence; 2 Low influence; 3 Moderate influence;4 High influence;5 Very high influence

Respondents were also asked to assess expected outcomes of implementing sustainable C&D waste management in Libya listed in Table (6.3), using exactly the same way suggested to improve sustainable C&D waste management in Libya by adopting scale order form 1-5 with the same categories. Table (6.3) shows that the majority of the respondents emphasised the efficacy of the application of sustainable C&D waste management in the country. Reducing negative environmental impact was cited as the most essential achievement outcome after applying of sustainable C&D waste management. Other significant outcomes following an application of sustainable C&D waste management as identified by respondents were maintaining health, wellbeing and general appearance and a new energy resource.

Table 6-2: Respondents' assessment of approach they think could improve construction and demolition waste

No	Please indicate which the following approach do you think could improve construction and demolition waste							
	A value of affecting / Approach	1	2	3	4	5	Count	Percent
1	More stringent enforcement of legislation and regulations for C&D waste.	3 10%	0 00%	0 00%	13 43%	14 45.7%	30	100%
2	Establishing a new sector responsible just for construction and demolition waste management.	2 6.7%	2 6.7%	4 13.3%	8 26.7%	14 46.7%	30	100%
3	Providing more funds to develop infrastructure construction and demolition waste management	1 3.3%	0 00%	5 16.7%	8 26.7%	16 53.3%	30	100%
4	Increasing awareness of the negative impact of construction waste has a positive influence on economy, environment and society by campaigns and social media	1 3.3%	2 6.7%	1 3.3%	14 46.7%	12 40%	30	100%
5	Increasing the investment on recycling and recovery of construction waste and providing and providing marketing for these products	1 3.3%	1 3.3%	3 10%	9 30%	16 53.3	30	100%
Count total		5	5	13	39	58		
Number of responses		30						

1Strongly disagree;2 Disagree;3 Neutral;4 Agree;5 Strongly agree

Table 6-3: Respondents' assessment of the outcome of implementing sustainable construction waste management

No	Please indicate the outcome of implementing sustainable construction waste management in Libya							
	A value of affecting / Outcome	1	2	3	4	5	Count	Percent
1	Providing new opportunities for job creation	**1 3.3%**	**0**	**1 3.3%**	**15 50%**	**13 43.3%**	30	100%
2	The economic benefits	**2 6.7%**	**0 00%**	**1 3.3%**	**13 43.3%**	**14 46.7%**	30	100%
3	Increasing reuse, recycling & recovery rate	**2 6.7%**	**0 00%**	**1 3.3%**	**13 43%**	**14 46%**	30	100%
4	Reducing the quantities of waste generation	**1 3.3%**	**2 6.7%**	**6 20%**	**14 46.7%**	**6 20%**	30	100%
5	Reducing in area for waste landfill	**1 3.3%**	**2 6.7%**	**5 16.7%**	**9 30%**	**13 43.3%**	30	100%
6	Reducing negative environmental impact	**2 6.7%**	**0 00%**	**2 6.7%**	**10 33.3%**	**16 53.3%**	30	100%
7	A new energy resource	**1 3.3%**	**2 6.7%**	**5 16.7%**	**7 23.3%**	**15 50%**	30	100%
8	Maintaining health, wellbeing and general appearance	**2 6.7%**	**1 3.3%**	**0 00%**	**9 30%**	**18 50%**	30	100%
Count total		**12**	**7**	**21**	**90**	**109**		
Number of responses		30						

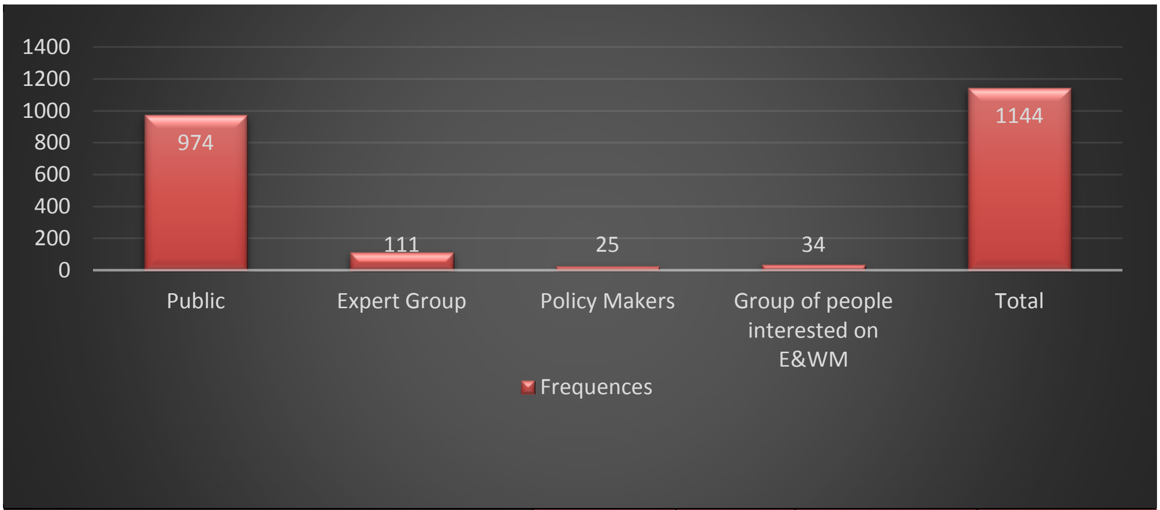
1Strongly disagree;2 Disagree;3 Neutral;4 Agree;5 Strongly agree

6.3 Results from Main Questionnaires Survey: Characteristics of the Respondents

In the main questionnaire survey multiple tests were conducted to meet the aim (nonparametric and parametric). Non-parametric statistical methods are most commonly utilised by researchers (Tabachinck and Fidell, 1989). Parametric test is more effective and generally needs less data to make a grounded conclusion than nonparametric tests (Neideen and Brasel, 2007).

6.3.1 Distribution of Respondents' Groups

Figure (6.5) represents the distribution of total respondents to the main questionnaire survey according to the kind of respondents' groups. As shown from the Figure (6.5), the public group had the highest number of respondents (almost 85.1% of the total). The expert group included 9.7% people interested in the environment and waste management (GPiE&WM), with about 3% of the total respondents coming from this survey. Approximately, 2.2% of the respondents are policy makers, which is the least number of respondents of the total. This is probably because the number of questionnaires distributed to the public group was higher that of other groups, and the general public are obviously more accessible for research purposes.

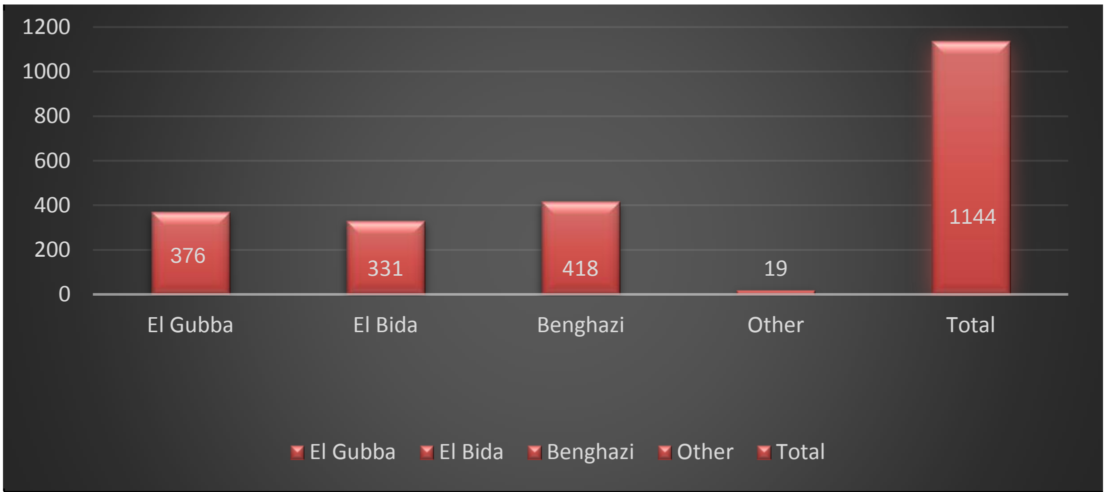


		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Public	974	85.1	85.1	85.1
	Expert group	111	9.7	9.7	94.8
	Policy maker	25	2.2	2.2	97.0
	GPiE&WM	34	3.0	3.0	100.0
	Total	1144	100.0	100.0	

Figure 6-5: Respondents' groups

6.3.1.1 *Respondents' Distribution by City*

Figure (6.6) represents the size of respondents (number of respondents according to the place of residence. It can be seen that there is no large difference between the numbers of respondents in the three cities, except participants from another place. Benghazi had the highest proportion of respondents (36.5%), followed by El Gubba and El Bayda at 32.9% and 28.9%, respectively. The least number of respondents come from other cities (approximately 1.7%). This reflects the case study sites (Benghazi, El Bayda and El Gubba) and Benghazi's larger net population.



		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	El Gubba	376	32.9	32.9	32.9
	El Bayda	331	28.9	28.9	61.8
	Benghazi	418	36.5	36.5	98.3
	Other	19	1.7	1.7	100.0
	Total	1144	100.0	100.0	

Figure 6-6: Respondents' groups by place of residence

6.3.1.2 *Characteristics According to Education Level*

Table (6.4) shows that approximately 58.7% of the respondents have a BSc/ high diploma qualification, 31.1% have other qualifications or no qualification at all, 8% have a Master degree and 2.1% have a PhD. This indicates that over 68.9% of the respondents are relatively well educated.

Table 6-4: Respondents according to education level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	PhD	24	2.1	2.1	2.1
	Master	92	8.0	8.0	10.1
	BSc/ High diploma	672	58.7	58.7	68.9
	Others	356	31.1	31.1	100.0
	Total	1144	100.0	100.0	

6.4 Assessment of Comprehension of C&D Waste Management

6.4.1 Assessment of Knowledge of C&D Waste Minimisation

Question 1 (Q1) of Section A2 of the questionnaire (see Appendix 1B) was analysed to assess the level of knowledge of the respondents on C&D waste management. As indicated in Table (6.5), out of the aggregate 1144 responses collected in the main survey, 1143 (99.9%) responses were obtained on this section of questionnaires, which means only one response was missed.

A gauge of "excellent" to "very poor" was utilised as a part of measuring the level of information of respondents in C&D waste minimisation. Nearly 33.6% of respondents believed they had "good" to "excellent" information of C&D waste minimisation, while 60.5% assessed their insight into C&D waste minimisation to be "fair" and "very poor". However, if the quantity of respondents "not sure" of their response to the question were considered among those with a very low grasp of waste minimisation knowledge, this would climb even higher. In this case, the vast majority of the survey population (over 60.5%) had a very low grasp of C&D waste minimisation.

Table 6-5: Assessment of respondents' knowledge of C&D waste minimisation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Excellent	70	6.1	6.1	6.1
	Very good	87	7.6	7.6	13.7
	Good	227	19.8	19.9	33.6
	Fair	185	16.2	16.2	49.8
	Poor	255	22.3	22.3	72.1
	Very poor	252	22.0	22.0	94.1
	Not sure	67	5.9	5.9	100.0
	Total	1143	99.9	100.0	
Missing	System	1	.1		
Total		1144	100.0		

6.4.1.1 Educational Qualifications (EQ) and Understanding of C&D Waste Minimisation

Table (6.6) illustrates the expected count frequency in each of the cells generated by the factorial combination of educational qualifications (EQ) and level of understanding C&D waste minimisation. Looking at the EQ and level of understanding C&D waste minimisation cross tabulation shown in Table (6.6), it can be seen that more respondents, irrespective of EQ, rated their understanding of C&D waste minimisation between "fair" and "poor" than between "fair" and "good".

Although there is a sign that there is reference to respondents with higher education, such as PhD, Master's and BSc degrees perhaps having a "good" or "fair" understanding. Possibly due to social desirability bias (ties in with high power distance in Libyan culture) – more educated people would not admit to ignorance. However, if we count the total proportion of "fair", "poor", "very poor" and "not sure" in the last row, it comes to 66.4%. This proportion of responses may be as a result of difference between EQ levels of respondents.

Table 6-6: EQ and level of knowledge of C&D waste minimisation cross tabulation

			Level of knowledge of C&D waste minimisation							Total
			Excellent	Very good	Good	Fair	Poor	Very poor	Not sure	
EQ	PhD	Count	2	1	7	5	5	3	1	24
		Expected count	1.5	1.8	4.8	3.9	5.4	5.3	1.4	24.0
		Within EQ	8.3%	4.2%	29.2%	20.8%	20.8%	12.5%	4.2%	100.0%
	Master	Count	4	6	11	30	20	15	6	92
		Expected count	5.6	7.0	18.3	14.9	20.5	20.3	5.4	92.0
		Within EQ	4.3%	6.5%	12.0%	32.6%	21.7%	16.3%	6.5%	100.0%
	BSc/ High diploma	Count	40	67	164	101	149	117	33	671
		Expected count	41.1	51.1	133.3	108.6	149.7	147.9	39.3	671.0
		Within EQ	6.0%	10.0%	24.4%	15.1%	22.2%	17.4%	4.9%	100.0%
	Others	Count	24	13	45	49	81	117	27	356
		Expected count	21.8	27.1	70.7	57.6	79.4	78.5	20.9	356.0
		Within EQ	6.7%	3.7%	12.6%	13.8%	22.8%	32.9%	7.6%	100.0%
Total		Count	70	87	227	185	255	252	67	1143
		Expected count	70.0	87.0	227.0	185.0	255.0	252.0	67.0	1143.0
		Within EQ	6.1%	7.6%	19.9%	16.2%	22.3%	22.0%	5.9%	100.0%

To investigate whether EQ differs on whether they have knowledge on C&D waste management, Chi-square test was used. Assumptions were checked and met. From Table (6.7) it can be seen that there is a significant relationship between education level and knowledge of understanding C&D waste minimisation: X^2 (18, N-1143) =82.40, p=.000; therefore, p<.05. Symmetric measures are appropriate to measure the strength of the relationship or effect size; if the association between variables is low, the value of statistic will be comparatively near to zero and large if the value of statistic is close to 1 (Mehta and Patel, 2011). Thus, according to the Kendall's tau-b (Table 6.8) the effect size is small (0.134).

Table 6-7: Chi-square tests for the relationship between EQ and level of understanding on C&D waste minimisation

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	82.396[a]	18	.000
Likelihood ratio	79.857	18	.000
Linear-by-linear association	18.643	1	.000
N of valid cases	1143		

a. 5 cells (17.9%) have expected count less than 5. The minimum expected count is 1.41.

Table 6-8: Symmetric measures (on minimisation)

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.134	.025	5.453	.000
N of Valid Cases		1143			

6.4.2 Assessment of Knowledge of C&D Waste Reuse

Table (6.9) outlines respondents' level of grasping the reuse of C&D waste. According to Table (6.9), of the whole sample of 1144 responses for main questionnaires, 1141 were obtained on this question (99.7% response rate). Gross missing data was 3, equivalent to 0.3% of gross responses. A scale from "excellent" to "very poor" scale has been used to measure the level of information of C&D waste reuse. Approximately 28.3% of respondents believed that they had a "excellent" to "good" information, while almost 64% assessed their insight into C&D waste reuse to be "fair" to "very poor". Almost 7.5% of total respondents, were "not sure" of their response to this question. This may likewise show that respondents had a few grasp of C&D waste reuse. By and large, approximately 71% of the survey population, independent from anyone else's recognition, had practically little or zero grasp of C&D waste reuse.

Table 6-9: Assessment of respondents' knowledge of C&D waste reuse

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Excellent	62	5.4	5.4	5.4
	Very good	84	7.3	7.4	12.8
	Good	177	15.5	15.5	28.3
	Fair	120	10.5	10.5	38.8
	Poor	249	21.8	21.8	60.6
	Very poor	363	31.7	31.8	92.5
	Not sure	86	7.5	7.5	100.0
	Total	1141	99.7	100.0	
Missing	System	3	.3		
Total		1144	100.0		

6.4.2.1 EQ and Understanding of C&D Waste Reuse

Table (6.10) shows a cross tabulation of EQ and the level of understanding of C&D waste reuse. Observing the EQ and level of understanding of C&D waste reuse cross tabulation shown in the table, it can be seen that more respondents, irrespective of EQ, ranked understanding on C&D waste reuse between "fair" and "poor" than between "fair" and "good"; some percentages show that respondents with higher education were more likely to have a better understanding. However, counting the total percentages obtained for "fair", "poor", "very poor" and "not sure" within level of EQ between respondents was 71.6%. This percentage of responses shows the lack of reuse C&D waste between the groups in general.

Table 6-10: EQ and level of knowledge of C&D waste reuse cross tabulation

			Level of knowledge of C&D waste reuse							Total
			Excellent	Very good	Good	Fair	Poor	Very poor	Not sure	
EQ	PhD	Count	2	0	8	3	6	4	1	24
		Expected count	1.3	1.8	3.7	2.5	5.2	7.6	1.8	24.0
		Within EQ	8.3%	0.0%	33.3%	12.5%	25.0%	16.7%	4.2%	100.0%
	Master	Count	6	4	12	21	18	25	6	92
		Expected count	5.0	6.8	14.3	9.7	20.1	29.3	6.9	92.0
		Within EQ	6.5%	4.3%	13.0%	22.8%	19.6%	27.2%	6.5%	100.0%
	BSc/ High diploma	Count	39	56	127	65	149	192	42	670
		Expected count	36.4	49.3	103.9	70.5	146.2	213.2	50.5	670.0
		Within EQ	5.8%	8.4%	19.0%	9.7%	22.2%	28.7%	6.3%	100.0%
	Others	Count	15	24	30	31	76	142	37	355
		Expected count	19.3	26.1	55.1	37.3	77.5	112.9	26.8	355.0
		Within EQ	4.2%	6.8%	8.5%	8.7%	21.4%	40.0%	10.4%	100.0%
Total		Count	62	84	177	120	249	363	86	1141
		Expected count	62.0	84.0	177.0	120.0	249.0	363.0	86.0	1141.0
		Within EQ	5.4%	7.4%	15.5%	10.5%	21.8%	31.8%	7.5%	100.0%

To examine whether education level impacts the level of understanding on C&D waste, reuse a Chi-square test was conducted. From Table (6.11) it can be seen that there is a significant relationship between educational level and understanding of C&D waste reuse: X^2 (18, N-1141) =60.5, p= .000, therefore p<.05. However, if the expected count of cells is less than 5, with more than 3 categories and more than 1 degree of freedom or If the expected count is less than 1 or < than 20%, this indicates that the assumptions for Chi-square test might not have been met, as observed in Table (6.11). Therefore, combining categories could be the solution to increase expected counts (Bryman, 2008).

Monte Carlo Method test also can be used in this case because it gives unbiased estimate of the exact p value for asymptotic of Pearson Chi-Square with 99% confidence, without the prerequisites of the p asymptotic process. Linear-by-linear can also be another option if the data is large but unbalanced (Mehta and Patel, 2011). Thus, to achieve robust results Monte Carlo Method and linear-by-linear association test were used for all similar cases in this study. From Table (6.11), based on both tests, the p value is significant between educational level and understanding of C&D waste reuse = .000, therefore $p<0.05$. Symmetric measures were used to measure the strength of the relationship or effect size. According to the Kendall's tau-b (Table 6.12), the effect size is small (0.129).

Table 6-11: Chi-square tests for the relationship between EQ and level of understanding on C&D waste reuse

	Value	df	Asymp. Sig. (2-sided)	Monte Carlo Sig. (2-sided)		
				Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound
Pearson Chi-Square	60.515[a]	18	.000	.000	.000	.000
Likelihood Ratio	59.556	18	.000	.000	.000	.000
Linear-by-Linear Association	19.054	1	.000	.000	.000	.000
N of Valid Cases	1141					

a. 6 cells (21.4%) have expected count less than 5. The minimum expected count is 1.30.

Table 6-12: Symmetric measures (on reuse)

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.129	.025	5.209	.000
N of Valid Cases		1141			

6.4.3 Assessment of Knowledge of C&D Waste Recycling

Table (6.13) displays respondents' level of grasping recycling C&D waste. Of the total 1144 responses to the main survey, 1142 (99.8%) of whole responses were obtained on this question. Gross missing data was 2, equivalent to 0.2% of gross responses.

To quantify respondents' comprehension level of C&D waste recycling, a scope of very poor to excellent was additionally utilised. About 24.8% of respondents believed they had a "good" to "excellent" information on C&D waste recycling. On the other hand, almost 65% of respondents also assessed their insight into C&D waste recycling to be "fair" and "very poor", which is the same percentage of information level for respondents on C&D waste reuse. This also indicates that respondents had a low grasp of C&D waste recycling. Overall, approximately 75.2% of the survey population had practically zero grasp of C&D waste reuse.

Table 6-13: Assessment of respondents' knowledge of C&D waste recycling

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Excellent	59	5.2	5.2	5.2
	Very good	70	6.1	6.1	11.3
	Good	154	13.5	13.5	24.8
	Fair	125	10.9	10.9	35.7
	Poor	235	20.5	20.6	56.3
	Very poor	384	33.6	33.6	89.9
	Not sure	115	10.1	10.1	100.0
	Total	1142	99.8	100.0	
Missing	System	2	.2		
Total		1144	100.0		

6.4.3.1 EQ and Understanding of C&D Waste Recycling

Table (6.14) represents a cross tabulation of EQ and level of understanding C&D waste recycling. It can be seen that more respondents, irrespective of EQ, rated their understanding on C&D waste recycling similar to C&D waste minimisation and reuse between "fair" and "poor" than between "fair" and "good". The indication of more qualified individuals having more understanding is still existent but less discernible. Also, if we count the total proportion of "fair", "poor", "very poor" and "not sure" in within EQ, we reach approximately the same proportion as C&D waste reuse, at 75.2%.

Table 6-14: EQ and level of knowledge of C&D waste recycling cross tabulation

			Level of knowledge of C&D waste recycling							Total
			Excellent	Very good	Good	Fair	Poor	Very poor	Not sure	
EQ	PhD	Count	3	0	4	5	4	6	2	24
		Expected count	1.2	1.5	3.2	2.6	4.9	8.1	2.4	24.0
		Within EQ	12.5%	0.0%	16.7%	20.8%	16.7%	25.0%	8.3%	100.0%
	Master	Count	6	7	8	17	25	24	5	92
		Expected count	4.8	5.6	12.4	10.1	18.9	30.9	9.3	92.0
		Within EQ	6.5%	7.6%	8.7%	18.5%	27.2%	26.1%	5.4%	100.0%
	BSc/ High diploma	Count	36	47	121	62	138	200	66	670
		Expected count	34.6	41.1	90.4	73.3	137.9	225.3	67.5	670.0
		Within EQ	5.4%	7.0%	18.1%	9.3%	20.6%	29.9%	9.9%	100.0%
	Others	Count	14	16	21	41	68	154	42	356
		Expected count	18.4	21.8	48.0	39.0	73.3	119.7	35.8	356.0
		Within EQ	3.9%	4.5%	5.9%	11.5%	19.1%	43.3%	11.8%	100.0%
Total		Count	59	70	154	125	235	384	115	1142
		Expected count	59.0	70.0	154.0	125.0	235.0	384.0	115.0	1142.0
		Within EQ	5.2%	6.1%	13.5%	10.9%	20.6%	33.6%	10.1%	100.0%

A Chi-square test was performed to determine the degree of association between EQ and level of understanding C&D waste recycling (Table 6.15). The result shows a statistically significant relationship between the two variables. There is a significant relationship between education level and knowledge of understanding C&D waste recycling: X^2 (18, N-1142) =64.6, p= .000, therefore p<.05. However, because 25% of expected count is less than 5 in Pearson Chi-Square test. Monte Carlo test is more robust, therefore, based on Monte Carlo and Linear-by Linear Association tests p value is significant between educational level and understanding of C&D waste recycling = .000, therefore p<.05. To measure the strength of the relationship or effect size symmetric measures were used. As shown from the Kendall's tau-b (Table 6.16) the effect size is small =0.135.

Table 6-15: Chi-square tests for the relationship between EQ and level of understanding on C&D waste recycling

	Value	df	Asymp. Sig. (2-sided)	Monte Carlo Sig. (2-sided)		
				Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound
Pearson Chi-Square	64.618[a]	18	.000	.000	.000	.000
Likelihood Ratio	67.319	18	.000	.000	.000	.000
1Linear-by-Linear Association	22.452	1	.000	.000	.000	.000
N of Valid Cases	1142					

a. 7 cells (25.0%) have expected count less than 5. The minimum expected count is 1.24.

Table 6-16: Symmetric measures (on recycling)

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.135	.024	5.604	.000
N of Valid Cases		1142			

6.4.4 Assessment of Knowledge of C&D Waste Recovery

Table (6.17) displays respondents' level of grasping recovery C&D waste. From the entire sample of 1144 responses, 1143 responses (99.9%) were obtained on this question. Gross missing data was 1, equivalent to 0.1% of gross responses. A scale between "very poor" to "excellent" has been used to assess the level of information of C&D waste recovery. Almost 19.7% of respondents believed they had "good" to "excellent" information of C&D waste recovery. On the other hand, almost 66% of respondents assessed their insight into C&D waste recovery to be amongst "fair" and "very poor". This may also indicate that respondents had a few understanding of C&D waste recovery. Overall, approximately 80.3% of the survey population had practically little or zero grasp of C&D waste recovery. However, it is likely that the percentage may be significantly higher than this because of social desirability bias in this kind of reported survey (Chung, 2008).

Table 6-17: Assessment of respondents' knowledge of C&D waste recovery

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Excellent	72	6.3	6.3	6.3
	Very good	40	3.5	3.5	9.8
	Good	113	9.9	9.9	19.7
	Fair	128	11.2	11.2	30.9
	Poor	205	17.9	17.9	48.8
	Very poor	422	36.9	36.9	85.7
	Not sure	163	14.2	14.3	100.0
	Total	1143	99.9	100.0	
Missing	System	1	.1		
Total		1144	100.0		

6.4.4.1 EQ and Understanding of C&D Waste Recovery

Table (6.18) illustrates a cross tabulation of EQ and level of understanding C&D recovery. It can be seen that more respondents, irrespective of EQ, rated their understanding on C&D waste recovery between "fair" and "poor" than between "fair" and "good", with less impact of higher EQ. Similarly, if we calculate the total percentage of "fair", "poor", "very poor" and "not sure" with reference to EQ with percentage C&D waste recovery, it is slightly higher at 80.3%.

Table 6-18: EQ and level of knowledge of C&D waste recovery cross tabulation

			Level of knowledge of C&D recovery							Total
			Excellent	Very good	Good	Fair	Poor	Very poor	Not sure	
EQ	PhD	Count	2	0	6	3	5	7	1	24
		Expected count	1.5	.8	2.4	2.7	4.3	8.9	3.4	24.0
		Within EQ	8.3%	0.0%	25.0%	12.5%	20.8%	29.2%	4.2%	100.0%
	Master	Count	5	7	6	8	19	38	9	92
		Expected count	5.8	3.2	9.1	10.3	16.5	34.0	13.1	92.0
		Within EQ	5.4%	7.6%	6.5%	8.7%	20.7%	41.3%	9.8%	100.0%
	BSc/ High diploma	Count	45	25	80	88	121	218	94	671
		Expected count	42.3	23.5	66.3	75.1	120.3	247.7	95.7	671.0
		Within EQ	6.7%	3.7%	11.9%	13.1%	18.0%	32.5%	14.0%	100.0%
	Others	Count	20	8	21	29	60	159	59	356
		Expected count	22.4	12.5	35.2	39.9	63.8	131.4	50.8	356.0
		Within EQ	5.6%	2.2%	5.9%	8.1%	16.9%	44.7%	16.6%	100.0%
Total		Count	72	40	113	128	205	422	163	1143
		Expected count	72.0	40.0	113.0	128.0	205.0	422.0	163.0	1143.0
		Within EQ	6.3%	3.5%	9.9%	11.2%	17.9%	36.9%	14.3%	100.0%

A Chi-square test was performed to determine the degree of association between EQ and level of understanding C&D waste recycling (Table 6.19). The results show a strong, statistically significant relationship between the two variables. It can be seen that there is a significant relationship between education level and knowledge of understanding C&D waste recovery: X^2 (18, N-1143) =43.8, p= .001, therefore p<.05. However, because 25% of expected count is less than 5 in Pearson Chi-Square test.

Monte Carlo test is more robust, therefore, based on Monte Carlo and Linear-by Linear Association tests p value is significant between educational level and understanding of C&D waste recovery = .001, therefore $p<.05$. Symmetric measures were used to measure the strength of the relationship or effect size. As shown from the Kendall's tau-b (Table 6.20) the effect size is small (=0.106).

Table 6-19: Chi-square tests for the relationship between EQ and level of understanding on C&D waste recovery

	Value	df	Asymp. Sig. (2-sided)	Monte Carlo Sig. (2-sided)		
				Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound
Pearson Chi-Square	43.848[a]	18	.001	.001	.000	.002
Likelihood Ratio	43.854	18	.001	.001	.000	.002
Linear-by-Linear Association	13.582	1	.000	.000	.000	.001
N of Valid Cases	1143					

a. *7 cells (25.0%) have expected count less than 5. The minimum expected count is .84.*

Table 6-20: Symmetric measures (on recovery)

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.106	.024	4.352	.000
N of Valid Cases		1143			

6.5 Assessment of Responses to Question B2: C&D Waste Collection and Transfer

Q5 in Section B was asked with the purpose of determining who is responsible for C&D waste collection and transfer (see Appendix 1B). Table (6.21) presents that of the total 1144 responses collected in the main survey, 1132 (99.0%) responses were received, with 12 missing data, equivalent to 1% of total responses. Table (6.21) shows that 9.9% of 1132 respondents considered that the General Environment Authority (GEA) is responsible for collection of C&D waste. In fact, this percentage should be lower because the GEA is a “consultative body”. It is accordingly conceivable that participants were misguided because of the frequent changes in the labels of bodies responsible for waste management. On the other hand, the percentage of respondents who believed that the Public Service Company is responsible for collecting and transfer C&D waste was approximately 31.1%, followed by 11%, 14.7% and 31.9% for contractors, specialised companies and yourself/ owner of the project, respectively.In fact, this is identical to the current situation on the ground, because through personal observations and the secondary data such as contracts between government agencies and contractors or companies, the contactors are generally responsible to collect and transfer C&D waste to authorised dump sites. Only 1.2% of respondents selected 'other'. Overall, the main reason behind the lack of direction of the participants is the lack of enforcement and clarity in policy on who is responsible for C&D waste collection and transfer.

Table 6-21: Construction and demolition waste collection and transfer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	General Environment Authority	113	9.9	10.0	10.0
	Public Service Company	353	30.9	31.2	41.2
	Contractors	125	10.9	11.0	52.2
	Specialised companies	166	14.5	14.7	66.9
	Yourself/ owner of the project	361	31.6	31.9	98.8
	Others	14	1.2	1.2	100.0
	Total	1132	99.0	100.0	
Missing	System	12	1.0		
Total		1144	100.0		

Table (6.22) represents a cross tabulation of C&D waste collection and transportation and responsible sector between cities. It can be seen that there is a difference between cities in who is responsible for C&D waste collection and transportation. As shown in Table (6.22), in El Gubba the Public Service Company came the first, while in El Buda and Benghazi 'Yourself/ owner of the project' was mainly considered responsible for collecting and transferring C&D waste.

Table 6-22: Collect and transfer of C&D waste cross tabulation

			Who collected and transfer of C&D waste						Total
			General Environment Authority	Public Service Company	Contractors	Specialised companies	Yourself/ owner of the project	Others	
Where do you live	El Gubba	Count	49	151	26	21	109	8	364
		Expected count	36.3	113.5	40.2	53.4	116.1	4.5	364.0
		Within where you live	13.5%	41.5%	7.1%	5.8%	29.9%	2.2%	100.0%
	El Bayda	Count	37	95	19	81	96	3	331
		Expected count	33.0	103.2	36.6	48.5	105.6	4.1	331.0
		Within where you live	11.2%	28.7%	5.7%	24.5%	29.0%	0.9%	100.0%
	Benghazi	Count	27	97	79	60	152	3	418
		Expected count	41.7	130.3	46.2	61.3	133.3	5.2	418.0
		Within where you live	6.5%	23.2%	18.9%	14.4%	36.4%	0.7%	100.0%
	Other	Count	0	10	1	4	4	0	19
		Expected count	1.9	5.9	2.1	2.8	6.1	.2	19.0
		Within where you live	0.0%	52.6%	5.3%	21.1%	21.1%	0.0%	100.0%
Total		Count	113	353	125	166	361	14	1132
		Expected count	113.0	353.0	125.0	166.0	361.0	14.0	1132.0
		Within where you live	10.0%	31.2%	11.0%	14.7%	31.9%	1.2%	100.0%

Chi-square test was performed to determine the degree of association between service of collection and transformation of C&D waste and who is responsible in each city (Table 6.23).

Table 6-23: Chi square for the relationship between service of collection and transformation of C&D waste and who responsible in each city

	Value	df	Asymp. Sig. (2-sided)	Monte Carlo Sig. (2-sided)		
				Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound
Pearson Chi-Square	124.418[a]	15	.000	.000	.000	.000
Likelihood Ratio	126.463	15	.000	.000	.000	.000
Linear-by-Linear Association	18.405	1	.000	.000	.000	.000
N of Valid Cases	1132					

a. 6 cells (25.0%) have expected count less than 5. The minimum expected count is .23.

The results show a statistically significant relationship between the two variables. It can be seen that there is a significant relationship between who is responsible for collection and transformation and case studies selected: X^2 (15, N-1132) =124.4, p= .000, therefore p<.05. However, because 25% of expected count is less than 5 in Pearson Chi square test. Monte Carlo test is more robust, therefore, based on Monte Carlo and Linear-by Linear Association tests p value is significant between how is responsible for collection and transformation and case studies selected = .000, therefore p<.05 Symmetric measures were used to measure the strength of the relationship or effect size. As shown from the Kendall's tau-b in Table (6.24) the effect size is small =0.110

Table 6-24: Symmetric measures (on collection and transfer)

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.110	.026	4.305	.000
N of Valid Cases		1132			

6.6 Assessment of Responses to Question B3: Measuring Performance of C&D Waste Management

6.6.1 Assessment of Performance in C&D Waste Reuse

Table (6.25) shows results from QB3 (1) in the questionnaire survey designed to assess real performance of C&D waste management based on respondents' opinion on each of level of reuse, recycling and recovery. From the total sample of 1144 responses, only 1 response was missing, equivalent to 0.1%. Only 12.1% of respondents believed or were satisfied that the level of performance of C&D waste reuse was between “excellent” to “good”.

Conversely, approximately 80.3% of respondents evaluated performance of C&D waste reuse in Benghazi, El Bayda and El Gubba to be between “fair” and “very poor”. However, if the sum of respondents who were “not sure” of their response to the question were taken into account, the percentage of respondents in this sort rose to 87.9%. The relatively high percentage of poor performers in C&D waste reuse corresponds to the general perception of selected cities. For instance, in the waste scene shown in Figure (6.7) there are some window parts that could be repaired and used for other buildings.

Table 6-25: Assessment of C&D waste reuse performance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Excellent	25	2.2	2.2	2.2
	Very good	30	2.6	2.6	4.8
	Good	83	7.3	7.3	12.1
	Fair	86	7.5	7.5	19.6
	Poor	330	28.8	28.9	48.5
	Very poor	502	43.9	43.9	92.4
	Not sure	87	7.6	7.6	100.0
	Total	1143	99.9	100.0	
Missing	System	1	.1		
Total		1144	100.0		

Figure 6-7: Construction and demolition waste scene with reusable window components

6.6.2 Assessment of Performance of C&D Waste Recycling

Table (6.26) shows the results from QB3 (2), designed to evaluate the real performance of C&D waste management based on respondents’ opinion of the level of recycling. It can be seen that of the total 1144 responses collected in the main survey, 1143 (99.9%) responses were received on this question, therefore only 1 missing data was equivalent to 0.1% of total responses. Roughly 8.3% of respondents ranked recycling performance of C&D waste between “good” to “excellent”. Conversely, approximately 81.2% of respondents believed that the performance of C&D waste recycling in the selected cities was between “fair” and “very poor”. Likewise, if the sum of respondents who were “not sure” of their response to the question were taken into account, the percentage of respondents in this sort rose to near 91.7%. The relatively high percentage of very poor performers in C&D waste recycling corresponds to the general perception of selected cities, as many C&D waste accumulations were observed while conducting the survey (Figure 6.8).

Table 6-26: Assessment of C&D waste recycling performance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Excellent	22	1.9	1.9	1.9
	Very good	16	1.4	1.4	3.3
	Good	57	5.0	5.0	8.3
	Fair	68	5.9	5.9	14.3
	Poor	305	26.7	26.7	40.9
	Very poor	555	48.5	48.6	89.5
	Not sure	120	10.5	10.5	100.0
	Total	1143	99.9	100.0	
Missing	System	1	.1		
Total		1144	100.0		

Figure 6-8: How C&D waste accumulates around cities

6.6.3 Assessment of Performance of C&D Waste Recovery

Table (6.27) shows results from a QB3 (3), designed to evaluate the factual performance of C&D waste management based on respondents' opinion of the level of recovery. There is no missing data out of total 1144 responses collected in the main survey. Approximately, 8.4% of respondents ranked recovery performance of C&D waste between "good" to "excellent". Conversely, around 79.6% of respondents believed the performance of C&D waste recovery in the selected cities was between "fair" and "very poor". If we include respondents who were "not sure" of their response to the question in this category, the percentage rises to 91.7%, which indicates an overwhelming perception of poor performance in C&D waste recovery.

Table 6-27: Assessment of C&D waste recovery performance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Excellent	21	1.8	1.8	1.8
	Very good	19	1.7	1.7	3.5
	Good	56	4.9	4.9	8.4
	Fair	58	5.1	5.1	13.5
	Poor	282	24.7	24.7	38.1
	Very poor	570	49.8	49.8	87.9
	Not sure	138	12.1	12.1	100.0
	Total	1144	100.0	100.0	

6.6.4 General Assessment of C&D Waste Management Performance

Q4 of Section B (see Appendix 1B) was analysed to assess how respondents' thought the overall performance practices of C&D waste management in the three cities. Table (6.28) shows the results from this question designed to evaluate actual performance of C&D waste management in general depend on respondents' opinion on the level of C&D waste management in general.

Table (6.28) presents that of the total 1144 responses collected in the main survey, 1138 answered this question (99.5%). The total missing data was 6, equivalent to 0.5% of total responses were received on this question. Approximately 9.1% of respondents ranked general performance of C&D waste between "good" to "excellent", while 86.6% of respondents considered the general performance of C&D waste in the selected cities to be between "fair" and "very poor". Similarly, if the number of respondents who were "not sure" of their response to the question were taken into account, the percentage of respondents in this sort rose to 91.2%, which is a very high percentage perceiving very poor performance of general C&D waste management.

Table 6-28: General assessment of C&D waste management performance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Excellent	11	1.0	1.0	1.0
	Very good	12	1.0	1.1	2.0
	Good	81	7.1	7.1	9.1
	Fair	77	6.7	6.8	15.9
	Poor	340	29.7	29.9	45.8
	Very poor	565	49.4	49.6	95.4
	Not sure	52	4.5	4.6	100.0
	Total	1138	99.5	100.0	
Missing	System	6	.5		
Total		1144	100.0		

6.7 Outline of Ways of C&D Waste Disposal in on Each of Selected Cities

Q5 in Section B was asked in order to ascertain if C&D waste is disposed of with other kinds of waste (see Appendix 1B). As shown in Table (6.29), out of 1144 responses collected in main questionnaires, 1134 (99.1%) responses were received to this question leaving 10 missing data and equivalent to 0.1% of total responses.

Table 6-29: Outline of methods of C&D waste disposal

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	560	49.0	49.4	49.4
	No	387	33.8	34.1	83.5
	Don't know	187	16.3	16.5	100.0
	Total	1134	99.1	100.0	
Missing	System	10	.9		
Total		1144	100.0		

Table (6.29) shows 387 responses, equivalent to 34.1% of total responses saying that C&D waste is disposed of separately. On the other hand, over 560 responses, equivalent to 49.4% of total responses, believed that C&D waste is disposed off with other types of waste. However, if the number of respondents who did not know their response were included in this category, it would rise to 65.9%, indicating a substantial majority considering that C&D waste is regularly disposed of with other kinds of waste, corroborating out observations (Figure 6.9).

Figure 6-9: How C&D waste is mixed with other kinds of waste

6.8 Outline Level of Environmental Consideration Waste Facilities in Libya

Q8 in Section C of the questionnaire was designed to evaluate level of environment consideration in waste facilities in selected cities. Table (6.30) shows that out of the total 1144 responses collected in this survey, 1138 (99.5%) answered this item, which indicates 6 missing data, equivalent to 0.5% of total responses.

The proportion of respondents who rated the practices as without environmental consideration was 923, which is approximately 81.1% (Table 6.30), a substantive majority. Only a small proportion (6.1%) of respondents believed that waste facilities have very good or good environmental consideration. On the other hand, just 146 respondents had no idea about the related subject. However, if the total respondents who did not know their response to the question were taken into account, this would rise to 93.9%; indicating a near unanimous perception that waste facilities in the case study areas have no regard for the environment.

Table 6-30: Level of environment consideration in waste facilities in selected cities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	923	80.7	81.1	81.1
	No	69	6.0	6.1	87.2
	Don't know	146	12.8	12.8	100.0
	Total	1138	99.5	100.0	
Missing	System	6	.5		
Total		1144	100.0		

6.9 Outline of Common C&D Waste Disposal Practices in Selected Cities

Q9, Section C was designed to identify common practices of C&D waste disposal in Benghazi, El Bayda and El Gubba. Table (6.31) demonstrates the outcomes. From

1144 responses collected in the survey, 1138 (99.5%) responses were received on this question.

Table (6.31) shows four particular approaches of waste disposal specified: sanitary landfills, open dumping, incinerators and burning in open site. Sanitary landfills were cited by only 98 respondents (8.6%). Indeed, based on existing evidence there are no engineered landfills (where landfill has been designed and constructed) in existence in the three selected cities (see Figures 6.10 and 6.11). It is accordingly conceivable that the erroneous perception of this minority is a consequence of deficient comprehension of the essential contrasts between sanitary landfills and common dumpsites with respect to a few respondents. From the table, we also deduce that approximately 42.5% believed the most common practice is open dumping.

Table 6-31: Most common methods of C&D waste disposal in selected cities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sanitary landfills	98	8.6	8.6	8.6
	Open dumping	484	42.3	42.5	51.1
	Incinerators	72	6.3	6.3	57.5
	Burning in open site	484	42.3	42.5	100.0
	Total	1138	99.5	100.0	
Missing	System	6	.5		
Total		1144	100.0		

The same proportion has been given by other respondents for burning in open site. On the other hand, only about 6.3% believed incinerators are the most common practice in the three cities. It is possible that the misconception proportion is as a result of conflating burning in open site and incinerators, because most of the incinerators based on personal observation were out of service.

This outcome corresponds with perception of previously published studies in Libya (Alhamroush and Altabet, 2005; Sawalem *et al.* 2009). Removal is the solution practiced by 95% of waste generated in Libya. In fact, 67% of this waste is either disposed off in open dump sites, and the 30% remain burned in the open site or municipal dumps comprising unauthorised dumping sites.

Figure 6-10: Common dumping sites (El Bayda), inside view (left) and outside site fence (right)

Figure 6-11: New dump site for El Gubba City, general views of site

6.10 Reasons for Open Dumping of C&D Waste in Selected Cities

Q10, Section C asked respondents to give reasons behind open dumping of C&D waste in the selected cities. Table (6.32) shows that respondents considered the main reasons behind open dumping of C&D waste to be no facilities, inadequate information about risks, no penalty and to save costs. Examples of such dumping are shown in Figure (6.12), from which the convenience of dumping can be summarised. As shown in Table (6.32), out of 1144 responses collected, 1138 (99.5%) responses were received on this question, with 6 missing data equivalent to 0.5%.

Figure 6-12: How C&D waste accumulates in cities and alongside roads

According to Table (6.32), 568 (49.9%) of respondents believed the main reason for open dumping was the lack of penalty, followed by 350 respondents (30.8%) who cited the lack of C&D waste management facilities was the main reason accountable for open dumping. Cost saving was cited by 10.9%, and inadequate information about risks by 8.4%. This tends to indicate divided opinions amongst respondents, connoting that all these reasons likely contribute to open dumping.

Table 6-32: Reasons for open dumping of C&D waste in selected cities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No facilities	350	30.6	30.8	30.8
	Inadequate information about risks	96	8.4	8.4	39.2
	No penalty	568	49.7	49.9	89.1
	To save cost	124	10.8	10.9	100.0
	Total	1138	99.5	100.0	
Missing	System	6	.5		
Total		1144	100.0		

6.11 Assessment of Responses on Best C&D Waste Management Strategies

Q11, Section C was asked in order to determine respondents' perspectives about which method is the best for adoption in the Libyan context. In this question, four particular methods of C&D waste management were specified: waste minimisation, recycling, energy generation, and backfill materials. Table (6.33) shows that out of 1144 responses collected in main questionnaires, 1143 (99.9%) responses were received on this question. As a result, only 1 missing data was equivalent to 0.1% of total responses. Only 7.9% of respondents (n=90) thought that waste minimisation is an appropriate approach. The majority of 608 respondents (53.2%) said recycling is the best approaches for C&D waste management in the country, while 260 responses (22.7%) cited energy generation. This percentage may have been affected by deficiency of electricity and blackouts resulting in the current situation in Libya. 185 of respondents (16.2%) believed that using C&D waste as backfill is the best approach. It can be deduced that all the approaches are suitable for the Libyan context, but the highest percentage given for recycling may indicate the perceived problem of the accumulated C&D waste in the selected cities.

Table 6-33: Environmentally friendly way to manage C&D waste in Libya

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Waste minimisation	90	7.9	7.9	7.9
	Recycling	608	53.1	53.2	61.1
	Energy generation	260	22.7	22.7	83.8
	Backfill materials	185	16.2	16.2	100.0
	Total	1143	99.9	100.0	
Missing	System	1	.1		
Total		1144	100.0		

Q12, Section C was asked to define respondents' perspectives about who is the best equipped to manage the C&D waste problem in Libya. In this question four particular options were specified: government agencies, private organisation, public-private, and individuals. As shown in Table (6.34), out of the total of 1144 responses collected in this survey, 1143 (99.9%) answered this question, which means only 1 data item was missing, equivalent to 0.1% of total responses. 157 respondents chose government agencies (13.7%) while only 1.6% of respondents believed that individuals would be the most convenient way to solve and manage the problem of C&D waste.

The majority (56.2%) favoured public-private partnerships, while 326 (28.5%) cited private, more than the percentage citing government agencies. This is a large indicator that people in these selected cities have low trust in the government to manage waste, or a desire to avoid government involvement in their rapacious business practices and try to cash in from any potentially responsible waste disposal efforts.

Table 6-34: Respondents' perspectives about who is the best equipped to manage the C&D waste problem in Libya

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Government agencies	157	13.7	13.7	13.7
	Private organisation	326	28.5	28.5	42.3
	Public-private	642	56.1	56.2	98.4
	Individuals	18	1.6	1.6	100.0
	Total	1143	99.9	100.0	
Missing	System	1	.1		
Total		1144	100.0		

6.12 Assessment of Responses of Expert Group, Policy Makers and Group of People Interested in Environment and Waste Management (GPiE&WM) on Current C&D Waste Management in Libya

This research has three questionnaires for four different sets. These questionnaires have a few different questions that are designed to have answers from an expert group or people involved in waste management. Therefore, these questions discuss the opinion of experts as people has more knowledge in the related subject. Table (6.35) shows distribution of expert respondents in this survey. It can be seen that 111 out of 170 respondents are experts (e.g. architect, civil engineering, contractor, environmentalist), equivalent to about 65.3% from the total respondents. On other hand, 25 respondents are policy makers, equivalent to 14.7%, which reflects the difficulty of meeting such people, particularly given the extraordinary situation in Libya since 2011. The last group is GPiE&WM. The number of respondents of this group is 34, equivalent to 20% of total respondents. More details on these groups were presented in the previous chapter. It should be noted that more respondents would have been included had the conditions in Libya been amenable.

Table 6-35: Expert groups

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Expert group	111	65.3	65.3	65.3
	Policy makers	25	14.7	14.7	80.0
	Group interested in environment and waste management	34	20.0	20.0	100.0
	Total	170	100.0	100.0	

This question was asked with the purpose of discovering if there is any existing strategy for managing C&D waste in Libya. As shown in Table (6.36), over 119 respondents (70%) of the total said there is no specific strategy for managing C&D waste. On the contrary, only three respondents (1.8%) said there was a functional strategy, while 14.7% said there was a strategy but it was not applied, and a similar amount (n=23, 13.5%) said they were unsure if there was a strategy for managing C&D waste. If the latter are included in those who believe there is no strategy for C&D waste, the percentage climbs even higher. Overall, this very clear indication that Libya suffering from an absence of effective strategies to deal with this issue.

Table 6-36: Assessment of C&D waste management strategies

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	1.8	1.8	1.8
	No	119	70.0	70.0	71.8
	Yes, but not applied	25	14.7	14.7	86.5
	Not sure	23	13.5	13.5	100.0
	Total	170	100.0	100.0	

6.12.1 Assessment of Organisational C&D Waste Management Strategies

This question was asked for a specific expert group in order to determine if there is any existing strategy for managing C&D waste on an organisation level. Table (6.37) shows that 111 responses were collected in this question. As shown in Table (6.37), 90 respondents (88.2%) did not agree that there is any specific strategy for managing C&D waste at the organisational level (e.g. construction companies), while only 12 (11.8%) agree that there is, thus it is clear that there is no specific approach to manage C&D waste at the organisational level, and no effective action is undertaken in this regard by studied firms.

Table 6-37: Assessment of specific strategy for managing C&D waste at organisation level

		Frequency	Percent	Valid percent
Valid	Yes	12	10.8	11.8
	No	90	81	88.2
	Total	102	91.8	100.0
Missing	System	9	8.2	
Total		111	100.0	

6.13 Assessment of Respondents about Adoption and Transfer Successful Strategies in ‘Developed Countries’ for Managing C&D Waste

This question designed was asked in order to discover respondents’ perspectives about the adoption and transfer of strategies successful in developed countries for the management of C&D waste. Table (6.38) shows that out of 170 expert respondents, 111 (65.3%) agreed with adopting successful strategies from developed countries, while only 15 (8.8%) disagreed. A more nuanced view was taken by 44 (25.9%), who believed in the adoption of successful strategies from developed countries with some amendments for the local context. This is in line with several previous studies that indicated it was not possible to adopt successful strategies from developed countries wholesale and transpose them to different developing-country contexts (as discussed in Chapter 2). Generally, there is full awareness among respondents of the importance of considering the experiences of developed countries in the management of this type of waste.

Table 6-38: Assessment tendency of respondents about the adoption and transfer of successful strategy in 'developing countries' for managing C&D waste in Libya

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	111	65.3	65.3	65.3
	No	15	8.8	8.8	74.1
	Yes, with some amendments	44	25.9	25.9	100.0
	Total	170	100.0	100.0	

6.14 Assessment of the Outcome of Implementing SC&DWM in Libya

6.14.1 Assessment of Potential of Providing New Opportunities for Job Creation from Applying SC&DWM in Libya

The quantitative data gathered from Q14, Section C of the questionnaire measures the potential outcomes of implementing SC&DWM in Libya. In this question, eight expected outcomes of implementing SC&DWM in Libya were posited (see Appendix 1B). Table (6.39) shows that 1144 responses were collected from the main survey, which means there is no missing data. To measure respondents' perspectives on providing new opportunities for job creation from implementing SC&DWM in Libya, a scale from "strongly disagree" to "strongly agree" was used. As shown in Table (6.39), only 5% of respondents did not agree that implementing SC&DWM in Libya could deliver new job opportunities. On the other hand, most respondents (87%) agreed that there is great chance of providing new jobs beyond adoption SC&DWM in Libya, which increases to 95% with the inclusion of "neutral" responses. Overall, the clear majority of respondents believed that implementing SC&DWM practices could provide many job opportunities.

Table 6-39: Assessment of the potential for providing new opportunities for job creation from applying SC&DWM in Libya

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	42	3.7	3.7	3.7
	Disagree	15	1.3	1.3	5.0
	Neutral	91	8.0	8.0	12.9
	Agree	515	45.0	45.0	58.0
	Strongly agree	481	42.0	42.0	100.0
	Total	1144	100.0	100.0	

6.14.2 Assessment of Potential of Economic Benefits from Applying SC&DWM in Libya

Table (6.40) shows respondents' perceptions of the potential economic benefits of applying SC&DWM in Libya. Of the total 1144 responses, 1142 (99.8%) answered this question, with 2 missing data items (0.2%). To assess respondents' perspectives on the potential of economic benefits from applying SC&DWM in Libya, a scale from "strongly disagree" to "strongly agree" was utilised. Approximately 3.3% of respondents believed that implementing SC&DWM in Libya would not add any economic value, while 87.2% of respondents believed that it would.

Table 6-40: Assessment of the potential of economic benefits from applying SC&DWM in Libya

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	16	1.4	1.4	1.4
	Disagree	22	1.9	1.9	3.3
	Neutral	109	9.5	9.5	12.9
	Agree	549	48.0	48.1	60.9
	Strongly agree	446	39.0	39.1	100.0
	Total	1142	99.8	100.0	
Missing	System	2	.2		
Total		1144	100.0		

6.14.3 Assessment of Potential of Increasing Reuse, Recycling and Recovery Rate for C&D Waste in Libya by Adoption SC&DWM

As shown in Table (6.41), 4.2% of 1143 respondents disagreed and strongly disagreed that implementing SC&DWM would increase the rate of reuse, recycling and recovery, while the vast majority (87%) believed that reuse, recycling and recovery rate could be increased. A scale from "strongly disagree" to "strongly agree" was implemented. Table (6.41) shows that 8.8% of 1143 respondents were unsure about their responses ('neutral'). Overall, the vast majority of respondents said that implementing SC&DWM would increase reuse, recycling and recovery rate in Libya.

Table 6-41: Assessment of the potential of increasing reuse, recycling and recovery rate for C&D waste in Libya by adoption SC&DWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	23	2.0	2.0	2.0
	Disagree	25	2.2	2.2	4.2
	Neutral	101	8.8	8.8	13.0
	Agree	499	43.6	43.7	56.7
	Strongly agree	495	43.3	43.3	100.0
	Total	1143	99.9	100.0	
Missing	System	1	.1		
Total		1144	100.0		

6.14.4 Assessment of Potential of Reducing the Quantities of C&D Waste Generation by Adoption Sustainable Waste Management

Table (6.42) shows respondents' thoughts on the potential of reducing the quantities of C&D waste arising by implementation of SC&DWM in Libya. 1142 responses (99.8%) were collected for this item, with 2 missing data items (0.2%). To assess respondents' perspectives on potential of reducing the quantity of C&D waste production by implementation of SC&DWM in the country, a scale from “strongly disagree” to “strongly agree” was used. “Strongly disagree” or “disagree” was chosen by 7.5% while 925 (81%) said adoption SC&DWM would reduce C&D waste generation. Thus there is a belief in the implementation of SC&DWM to decrease C&D waste.

Table 6-42: Assessment of the potential of reducing the quantities of C&D waste generation by adoption SC&DWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	27	2.4	2.4	2.4
	Disagree	59	5.2	5.2	7.5
	Neutral	131	11.5	11.5	19.0
	Agree	485	42.4	42.5	61.5
	Strongly agree	440	38.5	38.5	100.0
	Total	1142	99.8	100.0	
Missing	System	2	.2		
Total		1144	100.0		

6.14.5 Assessment of Potential of Reducing in Area for Waste Landfill in Libya by Adoption of SC&DWM

According to table (6.43), 1143 respondents responded to this question (99.9% of 1144 responses, with only 1 missing data item). To assess respondents' perspectives on potential of reducing the area used for waste landfill in Libya by implementing SC&DWM a scale from “strongly disagree” to “strongly agree” also used. Nearly 8.1% of respondents selected "strongly disagree" and "disagree" for the potential of decreasing the land used as landfill for waste generation by applying sustainable management for C&D waste. Alternatively, 79.3% of respondents "agreed" that there is a prospect of reducing landfill area beyond the adoption of SC&DWM in Libya. In total, as indicated by respondents, there is a tendency to execute sustainable management for C&D waste to reduce landfill space in the country. However, the proportion of supporters for this topic probably was less than its predecessor. This may be due to this issue not being considered important by due to the vast terrain of Libya and its tiny population density (at the national level), although as noted previously most C&D waste tends to be dumped within and nearby cities, causing a problem for urban residents.

Table 6-43: Assessment of the potential of reducing in area for waste landfill in Libya by adoption SC&DWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	30	2.6	2.6	2.6
	Disagree	63	5.5	5.5	8.1
	Neutral	144	12.6	12.6	20.7
	Agree	424	37.1	37.1	57.8
	Strongly agree	482	42.1	42.2	100.0
	Total	1143	99.9	100.0	
Missing	System	1	.1		
Total		1144	100.0		

6.14.6 Assessment of Potential of Reducing Negative Environmental Impact by Adoption SC&DWM

As shown in Table (6.44), 99.9% of 1144 respondents answered this question, with only 1 missing data item. A scale from "strongly disagree" and "strongly agree" was also applied to assess respondents' perspectives on the potential of reducing negative environmental impacts by the adoption SC&DWM in the Libyan context. Only 4% of respondents believed that implementing SC&DWM in Libya would not reduce negative impacts on the environment. Correspondingly, 998 (87.3%) believed that implementing SC&DWM in Libya certainly contributes in reducing negative influences on the environment. However, a respectable proportion of respondents selected "neutral". Overall, majority of respondents are tending to drive SC&DWM for decreasing negative impact of C&D on environment. However, a notable percentage of respondents selected "neutral", indicating a need for increased awareness of the benefits of SC&DWM for the environment.

Table 6-44: Assessment of the potential of reducing negative environmental impact in Libya by adoption SC&DWM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	23	2.0	2.0	2.0
	Disagree	23	2.0	2.0	4.0
	Neutral	99	8.7	8.7	12.7
	Agree	397	34.7	34.7	47.4
	Strongly agree	601	52.5	52.6	100.0
	Total	1143	99.9	100.0	
Missing	System	1	.1		
Total		1144	100.0		

6.14.7 Assessment of Potential of Using C&D Waste a New Energy Resource by Adoption Sustainable Waste Management

As shown in Table (6.45) the same scale was used to assess potential of utilising C&D waste as energy resource. 62 (5.4%) out of 1143 responded to this question with “strongly disagree” to “disagree”, while 109 respondents (9.5%) were “neutral”, while the great majority (85%) “agree” or “strongly agree” that sustainable management will help use C&D waste as another energy resource.

Table 6-45: Potential of using C&D waste as a new energy resource by sustainable waste management adoption

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	24	2.1	2.1	2.1
	Disagree	38	3.3	3.3	5.4
	Neutral	109	9.5	9.5	15.0
	Agree	438	38.3	38.3	53.3
	Strongly agree	534	46.7	46.7	100.0
	Total	1143	99.9	100.0	
Missing	System	1	.1		
Total		1144	100.0		

6.14.8 Assessment of Potential Maintaining Health, Wellbeing and General Appearance by Adoption SC&DWM

Table (6.46) presents results about the possibility of maintaining health, wellbeing and general appearance by the adoption of SC&DWM, using a scale from “strongly disagree” to “strongly agree”. The total who “disagreed” or “strongly disagreed” was 29 (2.6%), while 46 (4%) were “neutral” and 1068 (93.5%) “strongly agreed” or “agreed” that SC&DWM will protect societal health and general appearance.

Table 6-46: Potential of maintaining health, wellbeing and general appearance by sustainable waste management adoption

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	18	1.6	1.6	1.6
	Disagree	11	1.0	1.0	2.6
	Neutral	46	4.0	4.0	6.6
	Agree	306	26.8	26.8	33.2
	Strongly agree	762	66.6	66.7	99.8
	Total	1143	99.9	100.0	
Missing	System	1	.1		
Total		1144	100.0		

6.15 MANOVA for Measuring Knowledge of C&D Waste Management

Figure (6.5) shows number of respondents from four groups which may had different knowledge of C&D waste minimisation, reuse, recycling and recovery. The one-way multivariate analysis of variance (one-way MANOVA) was actualised to characterise whether there are any contrasts between independent groups on more than one ceaseless dependent variable (C&D waste management activities). As shown in the Table (6.47), three key descriptive statistical parameters were used: mean, standard deviation and number of responses from each group. Q1 in Section A2 of the questionnaire was designed to assess respondents' understanding of C&D waste minimisation, reuse, recycling and recovery. The scale ranged from "excellent" to "very poor", with a "Fair" and "not sure" option. The codes for this scale were between 1 for excellent to 6 for very poor, and 7 for "not sure" which also can be considered as lack of knowledge on C&D waste management.

Based on Figure (6.13) data have normal distribution. However, Fgure (6.5) shows number of respondents are not equal 974 were public, 111 expert group, 25 policy maker and 34 group interested on environment and waste management (GPiE&WM). The Pillai's criterion is therefore, the most vigorous of four possible statistical tests (Willks's lambda, Pillai's trace criterion, Roy's ger and Hotelling's tracerion), implying that output results that are most likely to be correct notwithstanding when assumption for MANOVA being violated. Thus, when the sample is quite small, and when the unequal size in the group or essential assumption is known to be violated, Pillai's criterion may be the most suitable test statistic (Denise, 1996).

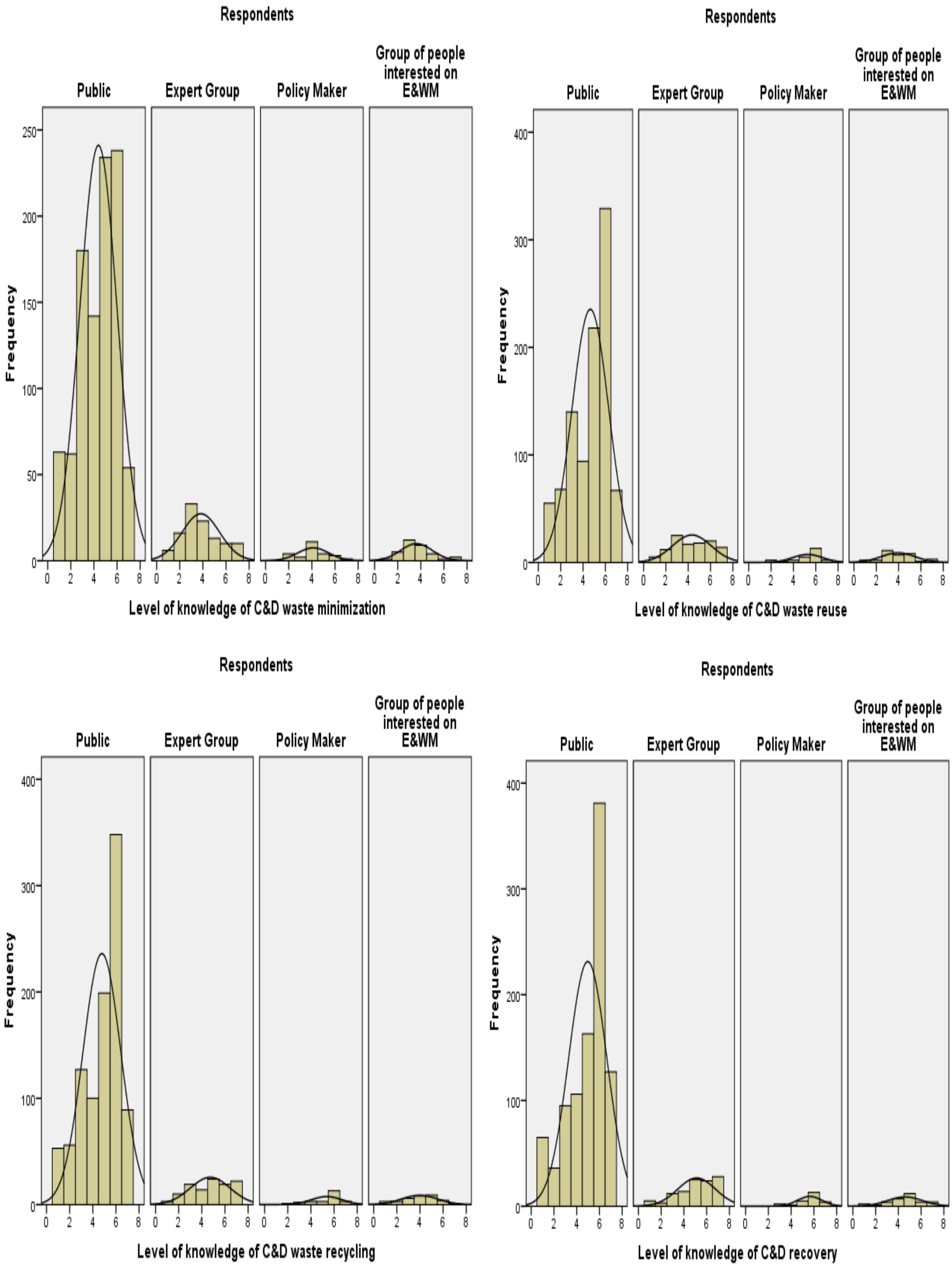


Figure 6-13: Histogram of data distribution

Table (6.47) shows mean results, taking into account the scale implemented in this question between (1) for "excellent" to (6) for "very poor". We can see that public had the worst knowledge on C&D waste minimisation, with a mean score of 4.39, followed by policy makers, with a mean of 4.12, then the expert group; therefore, the GPiE&WM had the highest understanding of C&D waste minimisation. The ranking of groups differed slightly when reuse, recycling and recovery of C&D waste were analysed. The policy makers group had the worst understanding of C&D waste reuse, recycling and recovery with mean scores of 5.28, 5.36 and 5.64, respectively (Table 6.47). They were followed by the public group, with mean scores of 4.65 for reuse, 4.79 for recycling and 4.97 for recovery. In this respect, the expert group ranked after the public group regards to C&D waste reuse, recycling and recovery with means of 4.32, 4.72 and 5.12 respectively. Table (6.47) shows that GPiE&WM had the highest understanding of C&D waste management with mean 3.62 for minimisation, 3.94 for reuse, 3.97 and 4.59 for recovery. Overall, although the GPiE&WM had little knowledge related to the subject, but the results reflect a lack of knowledge in these subjects especially on C&D waste recovery.

Table 6-47: Descriptive statistics (on level of knowledge of C&D waste management)

	Respondents	Mean	SD	N
Level of knowledge of C&D waste minimisation	Public	4.39	1.609	970
	Expert group	3.82	1.625	111
	Policy maker	4.12	1.333	25
	GPiE&WM	3.62	1.371	34
	Total	4.31	1.610	1140
Level of knowledge of C&D waste reuse	Public	4.65	1.645	970
	Expert group	4.32	1.733	111
	Policy maker	5.28	1.339	25
	GPiE&WM	3.94	1.516	34
	Total	4.61	1.652	1140
Level of knowledge of C&D waste recycling	Public	4.79	1.644	970
	Expert group	4.72	1.722	111
	Policy maker	5.36	1.319	25
	GPiE&WM	3.97	1.547	34
	Total	4.77	1.649	1140
Level of knowledge of C&D recovery	Public	4.97	1.676	970
	Expert group	5.12	1.661	111
	Policy maker	5.64	1.075	25
	GPiE&WM	4.59	1.540	34
	Total	4.99	1.662	1140

The Box's Test of Equality of Covariance Matrices (Table 6.48) examines the assumption of homogeneity of covariance across the groups utilising $p < .001$ as a criterion. For our example, we do not have a concern – as Box's M (72.7) was not significant, p (.000) < α (.001) – indicating that there are significant differences between the covariance matrices, therefore the assumption is violated and Pillai's criterion is an appropriate test to use.

Table 6-48: Box's test

Box's Test of Equality of Covariance Matrices[a]	
Box's M	72.706
F	2.327
df1	30
df2	25978.923
Sig.	.000

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

The following is the MANOVA using the Pillai's Trace test (Table 6.49). Using an alpha level of .05, we see that this test is significant, Pillai's Λ = .044, F (12, 3405) = 4.2, p < .001, multivariate η^2 = 0.15. This significant F indicates that there are significant differences among the respondents' groups on a linear combination of the dependent variables.

Table 6-49: Multivariate tests

Effects		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercepts	Pillai's Trace	.655	537.576[b]	4.000	1133.000	.000	.655
	Wilks' Lambda	.345	537.576[b]	4.000	1133.000	.000	.655
	Hotelling's Trace	1.898	537.576[b]	4.000	1133.000	.000	.655
	Roy's Largest Root	1.898	537.576[b]	4.000	1133.000	.000	.655
Participants	Pillai's Trace	.044	4.215	12.000	3405.000	.000	.015
	Wilks' Lambda	.957	4.229	12.000	2997.928	.000	.015
	Hotelling's Trace	.045	4.236	12.000	3395.000	.000	.015
	Roy's Largest Root	.029	8.357[c]	4.000	1135.000	.000	.029

Based on Levene's Test of Equality of Error Variances tests used to test the assumption of MANOVA and ANOVA, the variances of each variable are equal across the groups. Insomuch as the Levene's test is not significant, this means that the assumption has been not violated, therefore there is no need to view with caution – or the data could be transformed so as to equalise the variances. From Table (6.50), it can be seen that the assumption is met all the dependent variables, p > .05. Table (6.51) shows the test of between subject effects facilitates to determine the statistical significance of the level of variation between factors, however it did not show how these factors actually differed. To obtain this information, post-hoc test was applied.

Table 6-50: Levene's test of equality of error variances

	F	df1	df2	Sig.
Level of knowledge of C&D waste minimisation	2.595	3	1136	.052
Level of knowledge of C&D waste reuse	2.629	3	1136	.050
Level of knowledge of C&D waste recycling	1.666	3	1136	.173
Level of knowledge of C&D waste recovery	2.561	3	1136	.054

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

Table 6-51: Tests of between-subjects effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Level of knowledge of C&D waste minimisation	50.006[a]	3	16.669	6.521	.000	.017
	Level of knowledge of C&D waste reuse	37.237[b]	3	12.412	4.591	.003	.012
	Level of knowledge of C&D waste recycling	30.928[c]	3	10.309	3.819	.010	.010
	Level of knowledge of C&D waste recovery	18.084[d]	3	6.028	2.188	.088	.006
Intercept	Level of knowledge of C&D waste minimisation	3200.836	1	3200.836	1252.220	.000	.524
	Level of knowledge of C&D waste reuse	4168.193	1	4168.193	1541.782	.000	.576
	Level of knowledge of C&D waste recycling	4465.957	1	4465.957	1654.452	.000	.593
	Level of knowledge of C&D waste recovery	5196.683	1	5196.683	1886.184	.000	.624
Participant	Level of knowledge of C&D waste minimisation	50.006	3	16.669	6.521	.000	.017
	Level of knowledge of C&D waste reuse	37.237	3	12.412	4.591	.003	.012
	Level of knowledge of C&D waste recycling	30.928	3	10.309	3.819	.010	.010
	Level of knowledge of C&D waste recovery	18.084	3	6.028	2.188	.088	.006
Error	Level of knowledge of C&D waste minimisation	2903.763	1136	2.556			
	Level of knowledge of C&D waste reuse	3071.165	1136	2.703			
	Level of knowledge of C&D waste recycling	3066.471	1136	2.699			
	Level of knowledge of C&D waste recovery	3129.828	1136	2.755			
Total	Level of knowledge of C&D waste minimisation	24084.000	1140				
	Level of knowledge of C&D waste reuse	27369.000	1140				
	Level of knowledge of C&D waste recycling	29009.000	1140				
	Level of knowledge of C&D waste recovery	31548.000	1140				
Corrected Total	Level of knowledge of C&D waste minimisation	2953.768	1139				
	Level of knowledge of C&D waste reuse	3108.403	1139				
	Level of knowledge of C&D waste recycling	3097.399	1139				
	Level of knowledge of C&D waste recovery	3147.912	1139				

Table (6.52) presents the model – estimated marginal means and standard errors at 95% confidence interval, of level of understanding on C&D waste minimisation, reuse recycling and recovery; Table (6.53) outlines of grand mean for the dependent variables. From Table (6.52), it is conceivable to investigate the association impact between the factors and dependent variables. From the grand mean shown in Table (6.50), there is a difference between mean values across the dependent variable. This shows a great indication that there is a significant differential in level of understanding of C&D waste minimisation, reuse recycling and recovery.

Table 6-52: Model estimated marginal means and standard error

Dependent Variable	Respondents	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Level of knowledge of C&D waste minimisation	Public	4.390	.051	4.289	4.490
	Expert group	3.820	.152	3.522	4.118
	Policy maker	4.120	.320	3.493	4.747
	GPiE&WM	3.618	.274	3.080	4.156
Level of knowledge of C&D waste reuse	Public	4.653	.053	4.549	4.756
	Expert group	4.324	.156	4.018	4.631
	Policy maker	5.280	.329	4.635	5.925
	GPiE&WM	3.941	.282	3.388	4.494
Level of knowledge of C&D waste recycling	Public	4.786	.053	4.682	4.889
	Expert group	4.721	.156	4.415	5.027
	Policy maker	5.360	.329	4.715	6.005
	GPiE&WM	3.971	.282	3.418	4.523
Level of knowledge of C&D waste recovery	Public	4.974	.053	4.870	5.079
	Expert group	5.117	.158	4.808	5.426
	Policy maker	5.640	.332	4.989	6.291
	GPiE&WM	4.588	.285	4.030	5.147

Table 6-53: Grand mean (on level of knowledge of C&D waste management)

Dependent Variable	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Level of knowledge of C&D waste minimisation	3.987	.113	3.766	4.208
Level of knowledge of C&D waste reuse	4.550	.116	4.322	4.777
Level of knowledge of C&D waste recycling	4.709	.116	4.482	4.936
Level of knowledge of C&D waste recovery	5.080	.117	4.850	5.309

Based results of Table (6.51), Scheffe post-hoc test was applied to show how these factors actually differed (Table 6.54). On level of knowledge of C&D waste minimisation, there is only one statistically significant variation between public and policy makers group. On the level of knowledge of C&D waste reuse, there is also just one statistically significant variation, between policy makers and GPiE&WM. As

Table 6-54: Post-hoc test (on level of knowledge of C&D waste management)

Dependent Variable	(I) Respondents	(J) Respondents	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Level of knowledge of C&D waste minimisation	Public	Expert group	.57*	.160	.006	.12	1.02
		Policy maker	.27	.324	.875	-.64-	1.18
		GPiE&WM	.77	.279	.054	-.01-	1.55
	Expert group	Public	-.57-*	.160	.006	-1.02-	-.12-
		Policy maker	-.30-	.354	.869	-1.29-	.69
		GPiE&WM	.20	.313	.937	-.68-	1.08
	Policy maker	Public	-.27-	.324	.875	-1.18-	.64
		Expert group	.30	.354	.869	-.69-	1.29
		GPiE&WM	.50	.421	.700	-.68-	1.68
	GPiE&WM	Public	-.77-	.279	.054	-1.55-	.01
		Expert group	-.20-	.313	.937	-1.08-	.68
		Policy maker	-.50-	.421	.700	-1.68-	.68
Level of knowledge of C&D waste reuse	Public	Expert group	.33	.165	.265	-.13-	.79
		Policy maker	-.63-	.333	.315	-1.56-	.31
		GPiE&WM	.71	.287	.105	-.09-	1.51
	Expert group	Public	-.33-	.165	.265	-.79-	.13
		Policy maker	-.96-	.364	.076	-1.97-	.06
		GPiE&WM	.38	.322	.702	-.52-	1.29
	Policy maker	Public	.63	.333	.315	-.31-	1.56
		Expert group	.96	.364	.076	-.06-	1.97
		GPiE&WM	1.34*	.433	.023	.13	2.55
	GPiE&WM	Public	-.71-	.287	.105	-1.51-	.09
		Expert group	-.38-	.322	.702	-1.29-	.52
		Policy maker	-1.34-*	.433	.023	-2.55-	-.13-
Level of knowledge of C&D waste recycling	Public	Expert group	.06	.165	.984	-.40-	.53
		Policy maker	-.57-	.333	.395	-1.51-	.36
		GPiE&WM	.81*	.287	.045	.01	1.62
	Expert group	Public	-.06-	.165	.984	-.53-	.40
		Policy maker	-.64-	.364	.379	-1.66-	.38
		GPiE&WM	.75	.322	.144	-.15-	1.65
	Policy maker	Public	.57	.333	.395	-.36-	1.51
		Expert group	.64	.364	.379	-.38-	1.66
		GPiE&WM	1.39*	.433	.016	.18	2.60
	GPiE&WM	Public	-.81-*	.287	.045	-1.62-	-.01-
		Expert group	-.75-	.322	.144	-1.65-	.15
		Policy maker	-1.39-*	.433	.016	-2.60-	-.18-
Level of knowledge of C&D waste recovery	Public	Expert group	-.14-	.166	.864	-.61-	.32
		Policy maker	-.67-	.336	.271	-1.61-	.28
		GPiE&WM	.39	.290	.620	-.42-	1.20
	Expert group	Public	.14	.166	.864	-.32-	.61
		Policy maker	-.52-	.367	.567	-1.55-	.51
		GPiE&WM	.53	.325	.450	-.38-	1.44
	Policy maker	Public	.67	.336	.271	-.28-	1.61
		Expert group	.52	.367	.567	-.51-	1.55
		GPiE&WM	1.05	.437	.123	-.17-	2.28
	GPiE&WM	Public	-.39-	.290	.620	-1.20-	.42
		Expert group	-.53-	.325	.450	-1.44-	.38
		Policy maker	-1.05-	.437	.123	-2.28-	.17

Based on observed means.
The error term is Mean Square(Error) = 2.755.
*. The mean difference is significant at the .05 level.

shown in the Table (6.54), there is a statistically significant variation in the level of knowledge of C&D waste recycling between the public group and GPiE&WM, and also between policy makers and GPiE&WM.

On level of knowledge of C&D recovery, there is no statistically significant variation between all groups. The post-hoc test suggest that there is indeed need to carry out a sustained public education programme especially to the policy makers on C&D waste management both to bridge the variation in the level of knowledge amongst the groups as well as increase the overall knowledge of all respondent groups on management of C&D waste.

6.16 Barriers to SC&DWM in Libya

The review of the literature identified an incipient list of 19 barriers that may face adopting SC&DWM, especially in developing countries. One-way MANOVA was utilised to complete a between subjects, various examination investigation and comparison of barriers may hinder implementation of SC&DWM in Libya. Figure (6.14) below shows number of respondents from four groups which may had different thoughts on these barriers.

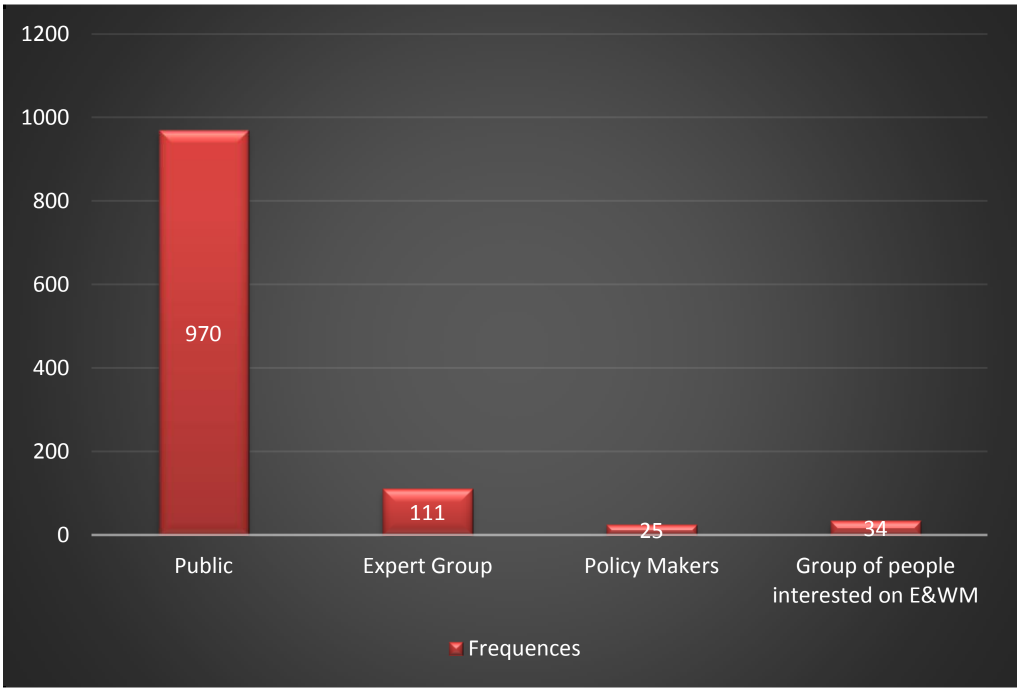


Figure 6-14: Respondents group

Table (Appendix 7) summarises the SPSS descriptive statistical analysis. The results show the number of respondents, means and standard deviation on the 19 identified barriers may hinder SC&DWM in the Libyan context. This table is designed instead of the original SPSS table to facilitate the process of comparison and clarify as much as possible the total average mean for each barrier, and the highest and lowest mean and number of respondents etc. From the legend of Table (Appendix 7) red indicates the total average of mean, green the lowest and purple the highest. A scale from 1 to 5 was used where 1 indicates “very low influence” and 5 indicates “very high influence” (Appendix 1B).

According to Table (Appendix 7) the first barrier to waste policies in Libya is the lack of clear strategies for action. The standard deviation for this barrier from mean rank is for the most part homogeneous, drawing nearer an estimation of 1.5. In addition, policy makers gave the highest mean at the level 4.84, followed by 4.05, 3.79 and 3.68 for expert group, public and GPiE&WM respectively.

From Table (Appendix 7) we can see that policy makers always have the highest mean on all barriers except barrier no. 11, for which the highest mean was exhibited by the public group at the level of 3.82, while the lowest was the expert group at the level 3.47. On the other hand, the lowest means often were from the public group, such as for the barriers no. 2, 3, 6, 7, 9, 10, 13 and 14 at the level 3.73, 3.91, 4.08, 4.03, 4.05, 4.14, 3.75 and 4.22, respectively. For all other barriers, such as no. 1, 4, 5, 8, 12, 15-19 the lowest means were at the level 3.68, 3.85, 3.85, 3.97, 3.47, 3.56, 3.97, 3.71, 4.00, 3.76 and 3.68 for GPiE&WM. Based on Table (see appendix 8), for Tests of Between-Subjects Effects the approximate (P) is less than 0.05, therefore there is a great indication of statistical variation between groups. Based on these results, Scheffe post-hoc test was used to find out where the difference lies.

Appendix (9) shows the model=estimated marginal means and standard errors at 95% confidence interval, to examine the interaction effect between barriers and group of respondents. Appendix (10) presents results from Scheffe post-hoc test. $P < 0.05$ indicates a significant variance between variables, in which case the cell is coloured green. It can be seen that variables, waste policies lack clear strategies for action, and there is significant variance between public and policy makers group, and between policy makers and GPiE&WM. On the second barrier there is no significant variance between the groups at all. This also applies to the barriers from 3- 8, 11, 14 and 19. Statistically significant variation was found on barrier no. 9 (operational equipment is obsolete and insufficient) between public group and policy makers, and this statistically significant variation existed between the same groups on the barrier no. 10 (there is no tax to control construction waste disposal).

Scheffe post-hoc test found that there is a significant variation for barrier no. 12 (encouragement, e.g. financial incentives) between expert group and policy makers and between expert group and GPiE&WM, as well as between policy makers and public and policy makers and GPiE&WM. On the barrier no. 13 (different waste management services from one place to another, e.g. city, town, village etc.) there is a statistically significant variation between public and policy makers group, expert group and policy makers, and policy makers and GPiE&WM.

Table 6-55: Grand mean (on barriers to SC&DWM)

Dependent Variable	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Waste policies lack clear strategies for action	4.089	.108	3.878	4.300
Laws regulating waste management are inadequate (lack of government interventions)	4.064	.108	3.853	4.275
Construction waste management institutions are weak	4.113	.104	3.908	4.318
Unplanned aspects of the city make construction waste collection difficult	4.105	.094	3.922	4.289
Availability of dumping grounds discourages expensive investment in alternative disposal methods	3.930	.100	3.734	4.126
Limited funds available are sometimes misused	4.335	.098	4.143	4.527
Public education on construction waste management is low	4.346	.100	4.150	4.542
Waste workers are poorly trained and poorly paid	4.275	.095	4.088	4.462
Operational equipment is obsolete and insufficient	4.328	.100	4.133	4.524
There is no tax to control construction waste disposal	4.444	.098	4.251	4.637
Types of material (e.g. produce unrecyclable materials)	3.645	.120	3.409	3.880
Encouragement (e.g. financial incentives)	4.178	.102	3.977	4.379
Different waste management service from one place to another (e.g. city, town, village etc.)	4.198	.113	3.976	4.420
Lack in the facilities of waste management	4.514	.098	4.321	4.707
The lack of reliable data base (quantity of C&D waste recycling reusing recovering and disposal)	4.294	.102	4.094	4.493
No review of waste management plans on a regular basis	4.213	.103	4.012	4.415
Lack of interest from clients	4.277	.097	4.087	4.468
Lack of market competition	4.237	.103	4.034	4.440
Attitude of some construction professional such as architects and engineers	3.855	.105	3.648	4.061

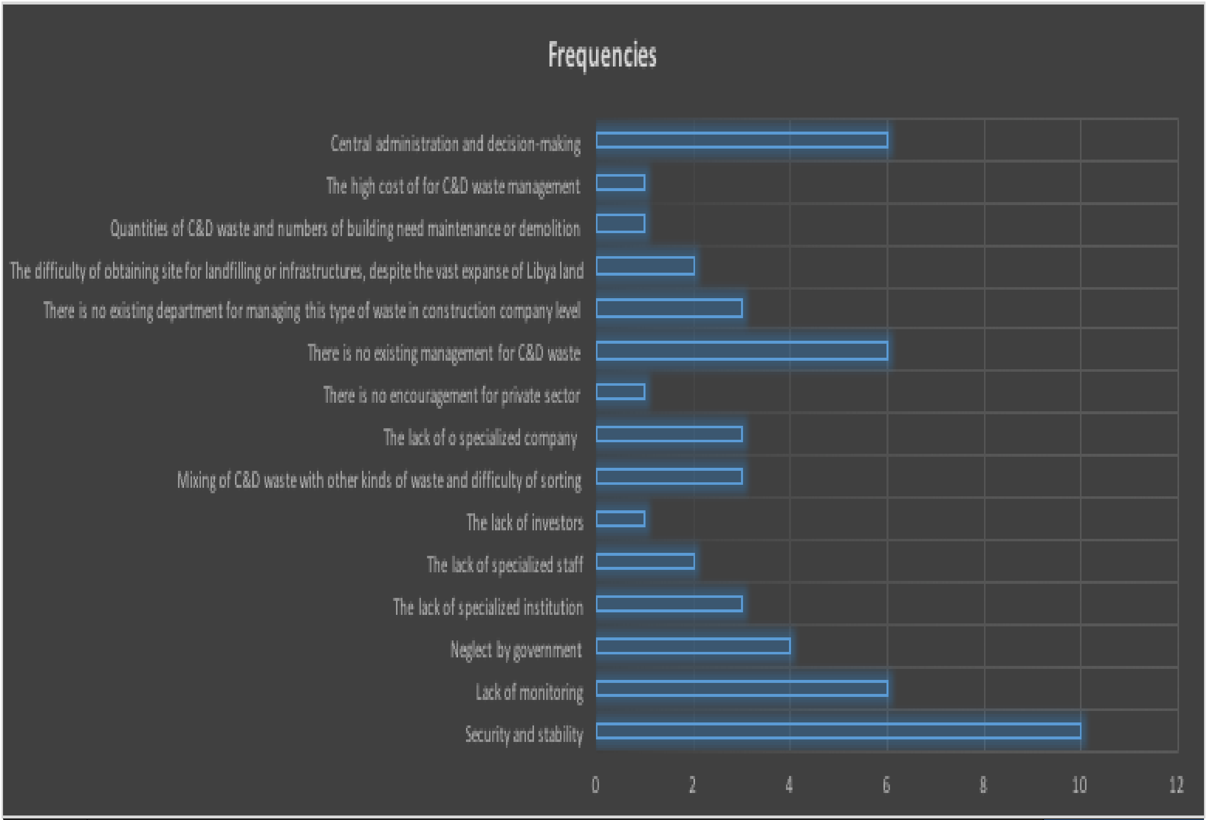
From Table (Appendix 10) it can be seen that on the barrier no. 15 (the lack of reliable data base; quantity of C&D waste recycling reusing recovering and disposal) there is just one statistically significant variation between public and policy makers group. On barrier no. 16 (no review of waste management plans on a regular basis), there was a significant variation between the public and policy maker groups, and between the policy makers and expert groups, and between policy makers and GPiE&WM.

Significant variations existed on barrier no. 17 (lack of interest from clients) between public and policy makers, as well as between the expert group and policy makers. As shown in Table (appendix 10), there is a statistically significant variation on barrier no. 18 (lack of market competition) between public group and policy makers, and also between policy makers and GPiE&WM. Based on the grand mean value table (6.55), the lack of waste management facilities is the most vital barrier to SC&DWM in Libya at the level 4.514, while the lowest barrier producing unrecyclable materials at level 3.645. According to grand mean Table (6.55), Table (6.56) illustrates the orderly rank for barriers facing SC&DWM from the most to least important barrier.

Table 6-56: Barriers to SC&DWM

NO	Barriers	Mean rank
1	Lack in the facilities of waste management	4.514
2	There is no tax to control construction waste disposal	4.444
3	Public education on construction waste management is low	4.346
4	Limited funds available are sometimes misused	4.335
5	Operational equipment is obsolete and insufficient	4.328
6	The lack of reliable data base (quantity of C&D waste recycling reusing recovering and disposal)	4.294
7	Lack of interest from clients	4.277
8	Waste workers are poorly trained and poorly paid	4.275
9	Lack of market competition	4.237
10	No review of waste management plans on a regular basis	4.213
11	Different waste management service from one place to another (e.g. city, town, village etc.)	4.198
12	Encouragement (e.g. financial incentives)	4.178
13	Construction waste management institutions are weak	4.113
14	Unplanned aspects of the city make construction waste collection difficult	4.105
15	Waste policies lack clear strategies for action	4.089
16	Laws regulating waste management are inadequate (lack of government interventions)	4.064
17	Availability of dumping grounds discourages expensive investment in alternative disposal methods	3.930
18	Attitude of some construction professional such as architects and engineers	3.855
19	Types of material (e.g. produce unrecyclable materials)	3.645

As shown in Figure (6.15), an additional 15 barriers were mentioned by respondents. In descending order of prevalence: barrier 1 was mentioned 10 times; barriers 2, 10 and 15 were cited 6 times; barrier 3 was mentioned 4 times; barriers 4, 7, 8 and 11 were noted 3 times; barriers 5 and 12 twice; and barriers 6, 9, 13 and 14 were only mentioned once by respondents.

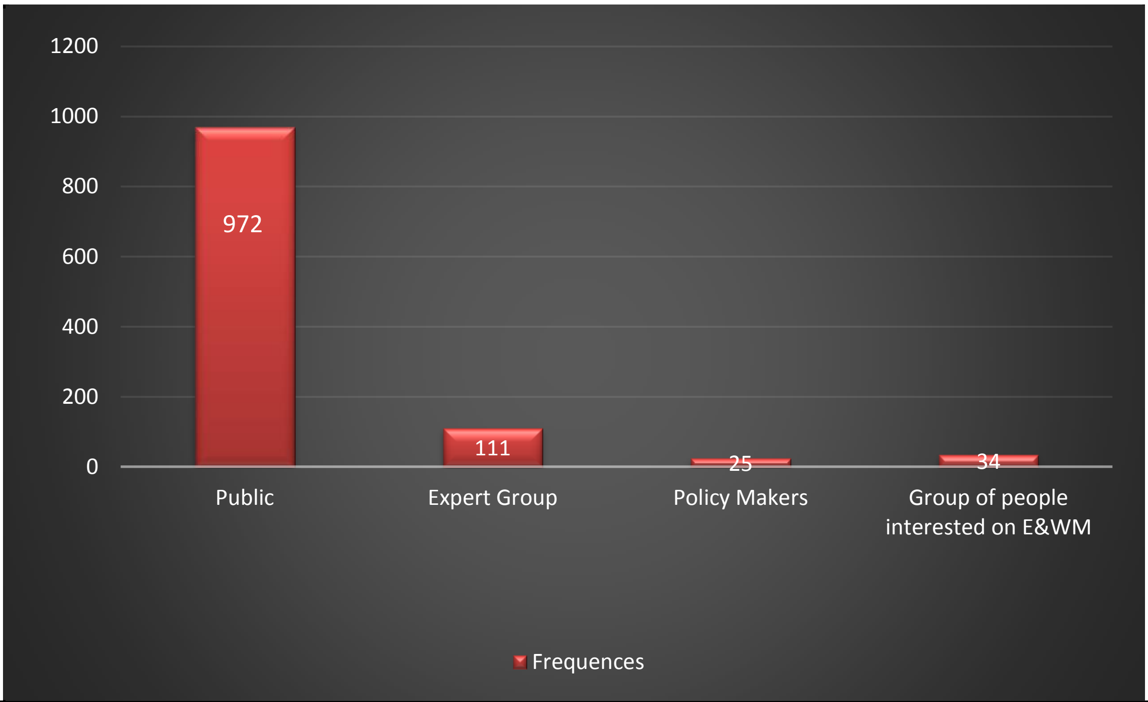


No.	Barrier	Frequencies
1	Security stability, and safety (e.g. especially abandoned munitions and unexploded ordnance)	10
2	Lack of monitoring	6
3	Neglect by government	4
4	The lack of specialised institution	3
5	The lack of specialised staff	2
6	The lack of investors	1
7	Mixing of C&D waste with other kinds of waste and difficulty of sorting	3
8	The lack of specialised company	3
9	There is no encouragement for private sector	1
10	There is no existing management for C&D waste	6
11	There is no existing department for managing this type of waste in construction company level	3
12	The difficulty of obtaining site for landfilling or infrastructures, despite the vast expanse of Libya	2
13	Quantities of C&D waste and numbers of building need maintenance or demolition	1
14	The high cost of for C&D waste management	1
15	Central administration and decision-making	6

Figure 6-15: Barriers noted by respondents to SC&DWM

6.17 Analysis of Policies and Strategies for SC&DWM

The literature identified an incipient list of five strategies that can be adopted towards SC&DWM. Likewise, one-way MANOVA was used to perform various examinations and comparison of strategies to help in the implementation of SC&DWM in Libya. As shown in Figure (6.16), 1144 respondents from four may have different beliefs on the importance of these strategies, but 2 data items were missing for this question.



		Value Label	Missed	N
Respondents	1	Public	2	972
	2	Expert group	0	111
	3	Policy maker	0	25
	4	GPiE&WM	0	34
	Total		2	1142

Figure 6-16: Respondents' groups

Table (6.57) summarises the SPSS descriptive statistical analysis. The results show the number of respondents, means and standard deviation for the five identified strategies that may help achieving sustainable management for C&D waste in Libyan. Table (6.57) was designed instead of an original SPSS table to facilitate the process of comparison and interpretation of the outcome as much as possible, such as the total average of mean for each strategy, highest and lowest mean and number of respondents. The legend with red shows the total average of mean, green the lowest and purple the highest. In this question a scale from 1 to 5 was used where 1 indicates “strongly disagree” and 5 “strongly agree” (Appendix 1B). Table (6.57) clearly shows that policy makers always had the highest mean rank on all strategies at levels 4.92, 4.92, 4.88, 488 and 4.80 for strategies 1-5, respectively.

On strategy no. 1 (more stringent enforcement of legislation and regulations for C&D waste the public group gave the lowest rank mean value at level 4.13 (SD 1).

Table 6-57: Summarised SPSS descriptive statistical analysis (on C&D waste management strategies)

Respondents Group	Strategies					
	1- More stringent enforcement of legislation and regulations for C&D waste			2- Establishing a new sector responsible just for C&D waste management		
	Mean	SD	N	Mean	SD	N
Public	4.13	.990	972	4.12	.883	972
Expert group	4.25	.929	111	4.10	.972	111
Policy maker	4.92	.277	25	4.92	.277	25
GPiE&WM	4.38	.779	34	4.15	.925	34
Total	4.17	.976	1142	4.14	.892	1142
Respondents Group	3- Providing more funds to develop infrastructure C&D waste management			4- Increasing awareness of the negative impact of construction waste has a positive influence on economy, environment and society by campaigns and social media		
	Mean	SD	N	Mean	SD	N
Public	4.27	.863	972	4.33	.825	972
Expert group	4.18	.876	111	4.32	.874	111
Policy maker	4.88	.332	25	4.88	.332	25
GPiE&WM	4.18	.758	34	4.47	.788	34
Total	4.27	.858	1142	4.35	.825	1142
Respondents Group	5- Increasing the investment on recycling and recovery of construction waste and providing and providing marketing for these products			Legend		
	Mean	SD	N	Total average		
Public	4.34	.846	972	Highest mean		
Expert group	4.30	.816	111	Lowest mean		
Policy maker	4.80	.408	25			
GPiE&WM	4.53	.507	34			
Total	4.35	.831	1142			

On strategy no. 2 (establishing a new sector responsible just for C&D waste management), the expert group had the lowest rank of 4.10, while the average of the mean for this strategy was about 4.14 (SD 0.9). On strategy no. 3 (providing more funds to develop infrastructure C&D waste management), the lowest mean was by expert and GPiE&WM at the level 4.18. The total average of means is about 4.27 (SD 0.86). As shown in Table (6.57), on strategy no. 4 (increasing awareness of the negative impact of construction waste has a positive influence on economy, environment and society by campaigns and social media, the lowest mean was by expert group at level 4.32, with average mean approximately 4.35 (SD 0.82). On strategy no. 5 (increasing the investment on recycling and recovery of construction waste and providing and providing marketing for these products), the expert group also provided the lowest mean value at level 4.30, with calculated mean rank of the strategy of 4.35 (SD 0.83). A grand mean table were used to rank these strategies (Table 6.58).

Table 6-58: Grand mean (on C&D waste management strategies)

Dependent Variable	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
More stringent enforcement of legislation and regulations for C&D waste.	4.422	.068	4.288	4.556
Establishing a new sector responsible just for C&D waste management	4.322	.062	4.200	4.444
Providing more funds to develop infrastructure C&D waste management	4.376	.060	4.257	4.494
Increasing awareness of the negative impact of construction waste has a positive influence on economy, environment and society by campaigns and social media	4.499	.058	4.386	4.613
Increasing the investment on recycling and recovery of construction waste and providing and providing marketing for these products	4.491	.058	4.376	4.605

Table (6.58) shows a summary of the grand means for each strategy 'dependence variable' with confidence interval at 95% and ranks them in order of prominence, based on bulk of grand mean values. According to a graphical plot of calculated grand mean values against the dependent variables (strategies) Figure (6.17); increasing awareness of the negative impact of construction waste to have a positive influence on economy, environment and society by campaigns and social media was perceived to be the key strategy to obtain sustainable management of C&D waste in Libya. On the other hand, the least vital strategy is establishing a new sector responsible just for C&D waste management.

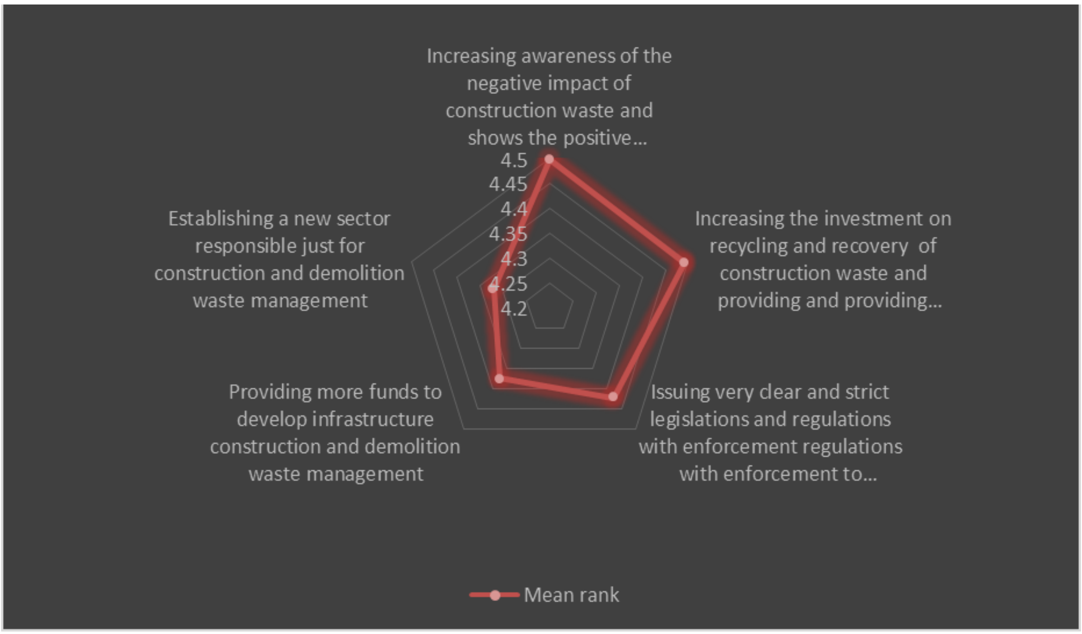


Figure 6-17: Order ranking of strategies that can be adopted for SC&DWM in Libya

This was followed by open-ended questions for experts and policy makers to suggest other strategies for improving C&D waste management in selected cities. As shown in Table (6.59), 170 responses were collected for this question from 25 respondents (14.7%), with 145 missing data items. Responses to this question raised some strategies that participants believed could help developing C&D waste management in the case studies.

Table 6-59: Respondents experts' groups

		Number of respondents	%
Groups	Expert group	111	65.3
	Policy maker	25	14.7
	GPiE&WM	34	20
Total		170	100

As shown in a Table (6.60), 10 strategies were suggested by respondents: strategy 1 (investment and cooperation with specialised companies have a long trading in this area) pointed five times, strategy 2 (training courses for people involve in waste management and construction sector) motioned twice, strategies 3, 4 and 5 once. Strategy 6 pointed 3 times. Strategies 8 (include themes related to environment and waste management in the new constitution for Libya) and 9 (refer to scientific bodies specialising in environmental sanitation and benefit from their knowledge) mentioned 1 and 3 respectively. The most frequently chosen strategy by respondents, which was cited 8 times, is (follow the example of development countries in this field). Strategy 10 (enforcing use C&D waste if the materials meet the prerequisite regulatory standards) was pointed out six times.

Table 6-60: Order ranking of outcome of a new strategies that can be adopted for C&D waste management in Libya

No.	Strategies	Frequencies
1	Investment and cooperation with specialised companies have a long trading in this area	5
2	Training courses for people involve in waste management and construction sector	2
3	Add penalty in construction projects	1
4	Accurate design of construction projects and development of urban schemes fixed	1
5	Waste management in conjunction with reconstruction in Libya	1
6	Purchase of C&D waste from citizens and contractors to stimulus transferring and sorting	3
7	Follow the example of development countries in this field	8
8	Include themes related to environment and waste management in the new constitution for Libya	1
9	Refer to scientific bodies specialising in environmental sanitation and benefit from their knowledge	3
10	Enforcing use C&D waste if the materials meet the prerequisite regulatory standards partially in reconstruction stage	6

6.18 Summary

A total of 1144 responses were made by all four selected groups surveyed in the main research. Of this number, 974 responses, proportionate to 85.1% were from public, 111 responses (9.7%) from expert group, 28 responses (proportionate to 2.2 %) from policy makers. 34 responses (3%) were collected from waste GPiE&WM. According to residential districts or location, 418 responses equivalent to 36.5 were from Benghazi, 376 responses, equivalent to 32.9% were from El Gubba, 331 responses (28.9%) were from El Bayda whilst only 19 responses equivalent to 1.7% were from other cities.

In the main survey, analysis of distribution of respondents according to education qualification shows that PhD had the least number 24 respondents at just about 2.1% of total respondents. Respondents have Master degree were 92 equivalent to 8%, respondents have BSc or High diploma had the highest number 672 respondents (58.7%), while, 356 respondents (31.1%) were had other education qualification.

An assessment of respondents' level of knowledge of waste management subjects such as waste minimisation, reuse recycling and recovery of C&D waste management illustrates that about 33.6% of respondents believed they had good to excellent information of C&D waste minimisation, while 60.5% assessed their insight into C&D waste minimisation to be fair and very poor. Approximately 28.3% of respondents said they had good to excellent knowledge of reuse. On the other had while almost 64% assessed their insight into C&D waste reuse to be fair to very poor. Nearly 24.8% of respondents said they had good to excellent information of recycling. This proportion compares poorly with approximately 65% of respondents who evaluated their grasp of recycling C&D waste to be between fair and very poor. Approximately 80% of respondents believed they had practically little or zero grasp of C&D waste recovery.

Performance of respondents on C&D waste related subjects such as reuse, recycling and recovery was also measured. About 80.3% of respondents rated performance of C&D waste reuse in Benghazi, El Bayda and El Gubba to be between fair and very poor. Conversely, almost 81.2% of respondents said that the performance of C&D waste recycling in the selected cities was between fair and very poor. About 79.6% for C&D waste recovery, which is almost the same percentage of poor performance that was given by respondents to recycling performance.

An assessment of respondents' show there is a difference between cities in who is responsible for C&D waste collection and transportation Table (6.22).

The majority of respondents believe that C&D waste is disposed off with other types of waste.

MANOVA shows a great indication that there is a significant differential in levels of knowledge between and within the four participated groups in levels of knowledge on key C&D waste management subjects (e.g. minimisation, reuse, recycling and recovery).

An assessment of respondents' shows that GPiE&WM had the highest understanding of C&D waste with mean 3.62 for minimisation, 3.94 for reuse, 3.97 and 4.59 for recovery. Overall, although the GPiE&WM had little knowledge related to the subject, but the results reflect a lack of knowledge in these subjects especially on C&D waste recovery Table (6.47). The policy makers group had the worst understanding of C&D waste reuse, recycling and recovery with mean scores of 5.28, 5.36 and 5.64, respectively.

The post-hoc test propose that there is indeed need to carry out a sustained public education programme on C&D waste management both to bridge the variation in the level of knowledge amongst the groups as well as increase the overall knowledge of all respondent groups on management of C&D waste.

The majority of respondents there is no specific strategy for managing C&D waste Table (6.36).

The majority of respondents said recycling is the best approach for C&D waste management in the country. In addition, respondents favoured public-private partnerships, as the best option to manage C&D waste.

Based on Table (6.37) there is also no specific strategy for reducing C&D waste at organisation level (e.g. construction companies).

In the Section (6.16), using MANOVA to analyse the main barriers affecting SC&DWM in the Libyan context. Interaction impacts between these barriers and participates groups were investigated. According to the Table 6.56 based on (grand mean values) is a classification of these barriers by order of importance. The lack of waste management facilities is the most vital barrier to SC&DWM in Libya, while the lowest barrier is types of material (e.g. produce unrecyclable materials). Also, an additional 15 barriers were mentioned by respondents. For instance, Security stability, and safety (e.g. especially abandoned munitions and unexploded ordnance) and central administration and decision-making mentioned as the main additional barriers (see Figure 6.15).

Section 6.17, using grand mean to analyse the strategies dependence variable may be developing SC&DWM in Libya. Interaction impacts between these strategies and participated groups were also thoroughly investigated. Figure (6.17) also, based on (grand mean values) is a classification of these strategies by order of importance. Increasing awareness of the negative impact of construction waste has a positive influence on economy, environment and society by campaigns and social media was perceived to be the key strategy to obtain sustainable management of C&D waste in Libya. On the other hand, the least vital strategy is establishing a new sector responsible just for C&D waste management. Furthermore, 10 strategies were suggested by respondents. As shown in a Table (6.60), the main vital strategy was investment and cooperation with specialised companies have a long trading in this area.

7 RESULTS OF FOCUS GROUP ANALYSIS

7.1 Introduction

This chapter outlines the outcomes from the focus group analysis completed in January 2017. As expressed in Chapter 5, the strategy was utilised essentially to validate and fortify evidence and findings collected from the main survey questionnaire. This chapter explains the objectives of the focus group, explores the barriers to SC&DWM identified, and strengthens evidence and findings that led to the framework development.

7.2 The Focus Group Sessions

7.2.1 Planning

The literature review and quantitative method (questionnaire survey) conducted provided critical ingredients for the proper understanding of present C&D waste management in Libya. Therefore, the FGD was conducted to produce additional beneficial supporting data particularly from experts in order to reinforce the quantitative data already gathered. To achieve the desired results, the FGD was planned and prepared with a relaxed and semi-formal environment that enabled participants discuss comprehensively all aspects of C&D waste management in Libya. Following a general introduction, a full group discussion was conducted with the facilitator. The FGD were recorded by audio and video (AV) equipment for subject transcription. The FGD was administered by the researcher. The information collected from the transcript was utilised to define the position of the participants to the related subject. This was conducted by questioning how participants themselves see the current situation of C&D waste and how it can be developed, with a view to developing a final framework with policy and strategies choices of adapting universal best practices in way germane to Libyan conditions.

7.2.2 Contact with Participants

For the purposes of this FGD, parallel group discussions were held with participants, with the researcher acting as the facilitator (see Figure 7.1). Participants were mainly drawn from Benghazi, El-Bayda and El-Gubba, the General Environment Authority, the Public Service Company, ministries, companies, academic staff and organisations related or involved in waste management or construction activities.

Figure 7-1: Researcher at FGD with stakeholders
Venue: Benghazi University, School of Civil Engineering

Contact with participants was based on their consent and providing their telephone numbers and email when they participated in the main questionnaire survey. According to Denzin and Lincoln (1994), the size of the FGD may differ from small (6 participants) to large (12 participants) and may or may not be administrated by a researcher. The process for recruitment of participants involved sending a formal invitation letter and subsequently a telephone confirmation of attendance when requested by the participant. Initial recruitment started in November, 2016. The total number of invitations sent to participants was 21, of whom 16 agreed to participate, and 11 ultimately attended. Appendix 3 (A and B) shows a copy of the invitation for participation in the FGD, and (C) lists all participants with their contact information.

Figure 7-2: Participants reviewing questionnaire survey results

The FGD was conducted for a period of two hours. The questionnaire survey results distributed and discussed with participants before starting the discussion (see Figure 7.2). To facilitate the discussion, different techniques were adopted with full group discussions, during which participants were divided into three groups of 4, 4 and 3 discussants based on their background to discuss the barriers and provide strategies to overcome these barriers (see Table 7.1 and Figure 7.3).

Table 7-1: Outline of participant groups in FGD

Group A	Group B	Group C
Lecturer, University of Benghazi (Civil Engineer)	Assistant lecturer, Higher Institute for Engineering Professions (Architect)	Public Service Company
Architecture Consultative Office (Architect)	Public Service Company	Assistant lecturer, Higher Institute of Polytechnics in Benghazi
General Environment Authority	A civil society organisation interested in the environment	National Board for Technical & Vocational Education
Libyan Audit Bureau	A private company for cleaning services	

Figure 7-3: Individual group discussion session

The primary factors taken into consideration while inviting participants were:

- Knowledge of the subject (due to the need for deep information)
- Participation in the questionnaire survey (based on contact information available and their consent during questionnaires survey to participate in FGD)
- Results of the questionnaire survey (to clarify some points from the questionnaires results)
- Spread, both in terms of geographical and sectorial representation (for the ability to generalise and avoid bias)

7.2.3 The Objectives of the FGD

The nature of the questions was basically such that clarifications in the areas of ambiguity were not generally needed as the questions followed from those originally asked in the questionnaires. The objectives of the FGD are:

- To provide a platform for participants to discuss the barriers that may hinder SC&DWM in Libya.
- To strengthen evidence and findings from the literature review (Chapters 2 to 4)
- To provide a platform for participants to discuss findings that led to the framework development.
- To prescribe policy options for achieving sustainable management of C&D waste in Libya based on available evidence.

7.3 Life Cycle of C&D Waste in Libya

Most participants agreed that C&D waste is treated as with other kinds of waste in Libya, mainly by dumping it in open areas, without any kind of waste management process. Figure (7.4) shows the C&D waste life cycle in Libya.

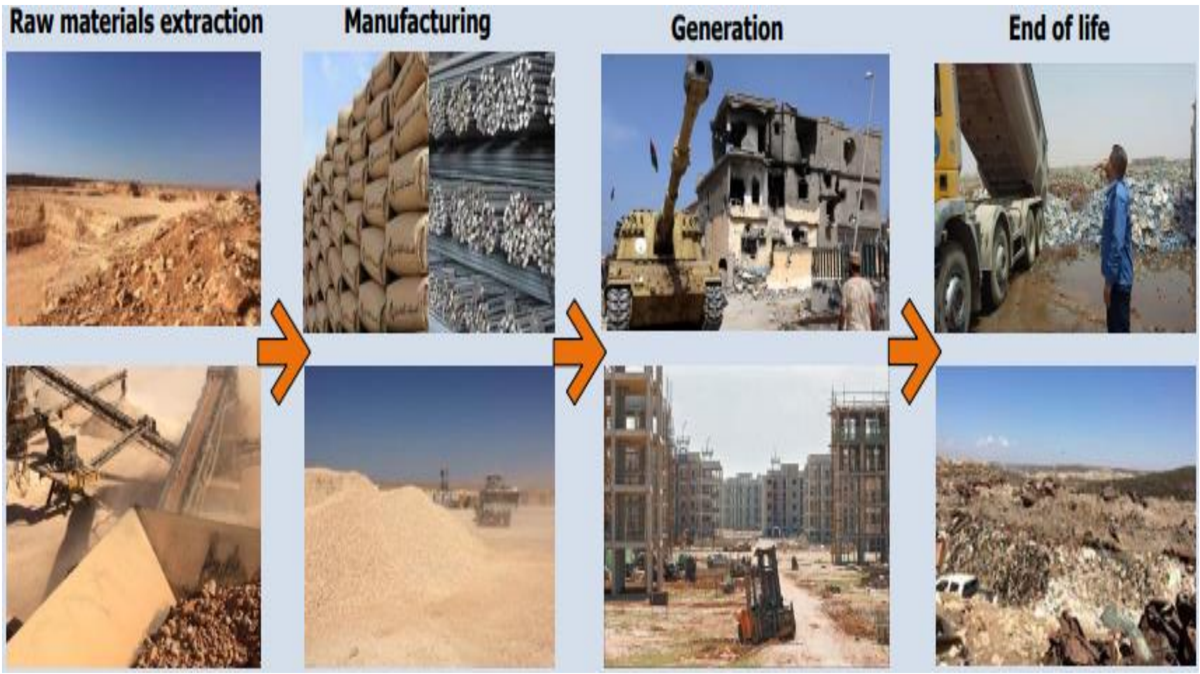


Figure 7-4: C&D waste life cycle in Libya

7.4 Overview of Barriers Affecting SC&DWM in Libya

Barriers affecting C&D waste management in Libya were outlined by participants in the FGD, Figure (7.5) shows the main barriers identified. The participants grouped and summarised the barriers identified from the main questionnaires. In general, the barriers fall into seven main categories: Policy and institutional, Specialists in C&D waste management, Equipment and facilities barriers, Physical barriers, Cultural perceptions, Economic barriers and Research and study barriers.

7.4.1 Policy and Institutional Barriers

The general position of the FGD was that, despite the importance and the needs of C&D waste management, especially at the present time with the massive accumulation of C&D waste as a consequence of war and normal construction activities, management of C&D in the selected cities is still grossly inadequate. For example, there is overlap between institutions, and over-reliance on government institutions. Moreover, an absence of details and enforcement in current legislations was found. The FGD recommended a review of the existing legislative framework supporting C&D waste management in Libya with a vision to designing an effective strategy based on universal best practises.

7.4.2 Lack of Specialists in C&D Waste Management

Despite the great number of employees in this sector, there is a severe shortage of specialised staff, especially administrative personnel, which prevents efficiency dealing with waste (e.g. to implement adequate planning to develop this sector). This may be due to a lack of training and controls in the employment process. The effect is that most waste departments in Libya are manned by lower-level personnel with little professional autonomy.

7.4.3 Equipment and Facilities Barriers

In the view of FGD, C&D waste in Libya is still at a very rudimentary stage, as only conventional approaches of collection and transfer are used. Equipment and facilities for management process are in a very poor and sometimes non-existent, reflected in a lack maintenance and the unavailability of spare parts. There is an egregious lack of infrastructure, for example recycling plants. The FGD recommended that when contracting with supply companies, the latter must be trained in how to conduct maintenance and the timetable for that, and spare parts should be provided.

7.4.4 Physical Barriers

Mixing all types of waste with C&D waste is a major hindrance of sustainable management. Haphazard construction without adherence to national building codes (such as they are) makes it difficult to control and identify whereabouts and the accumulation quantities of C&D waste or to estimate quantities. Similarly, the easy availability of disposal sites in many parts of Libya are a motivation or cause for fly tipping and a hurdle against more sustainable but prohibitively expensive disposal choices.

7.4.5 Cultural Perceptions Barriers

Participants were of the certain view that the main obstacle affecting SC&DWM is cultural perceptions. The socio-cultural perceptions in Libya about waste management need to be changed. Despite the full conviction of the theoretical benefits of waste management, there are deficiencies in the application and a widespread perception that people who work in this area or who are practically engaged in waste management comprise an inferior class, even in administrative terms. Attitude of some construction professionals such as architects and engineers and there is lack of interest in waste minimisation at the design stage. The FGD recommended motivating and attracting human resources with incentives and increasing public awareness of the importance of C&D waste management.

7.4.6 Economic Barriers

Despite Libya being one of the richest countries in Africa, there is very limited funding offered to waste management authorities, and the funding that does exist is not always applied judiciously; due to a lack of proper planning and culture, officials often lack of adequate control over how to deploy funds.

7.4.7 Lack of Research and Studies

The participants were of the view that the lack of research and study (i.e. education) is another barrier toward sustainable management for C&D waste. For instance, there is lack of waste management in the educational system in Libya, even in faculties related to the sector. Equally, there is a lack of research about waste management, particularly concerning C&D waste. The effect is that there is no reliable data about quantities or components of C&D waste and other kinds of waste as well. Therefore, participants recommended the need to establish a comprehensive database containing all the information about the types of waste, characteristics and quantities, which could be by commissioning, funding and adopting studies (e.g. by universities and research centres).

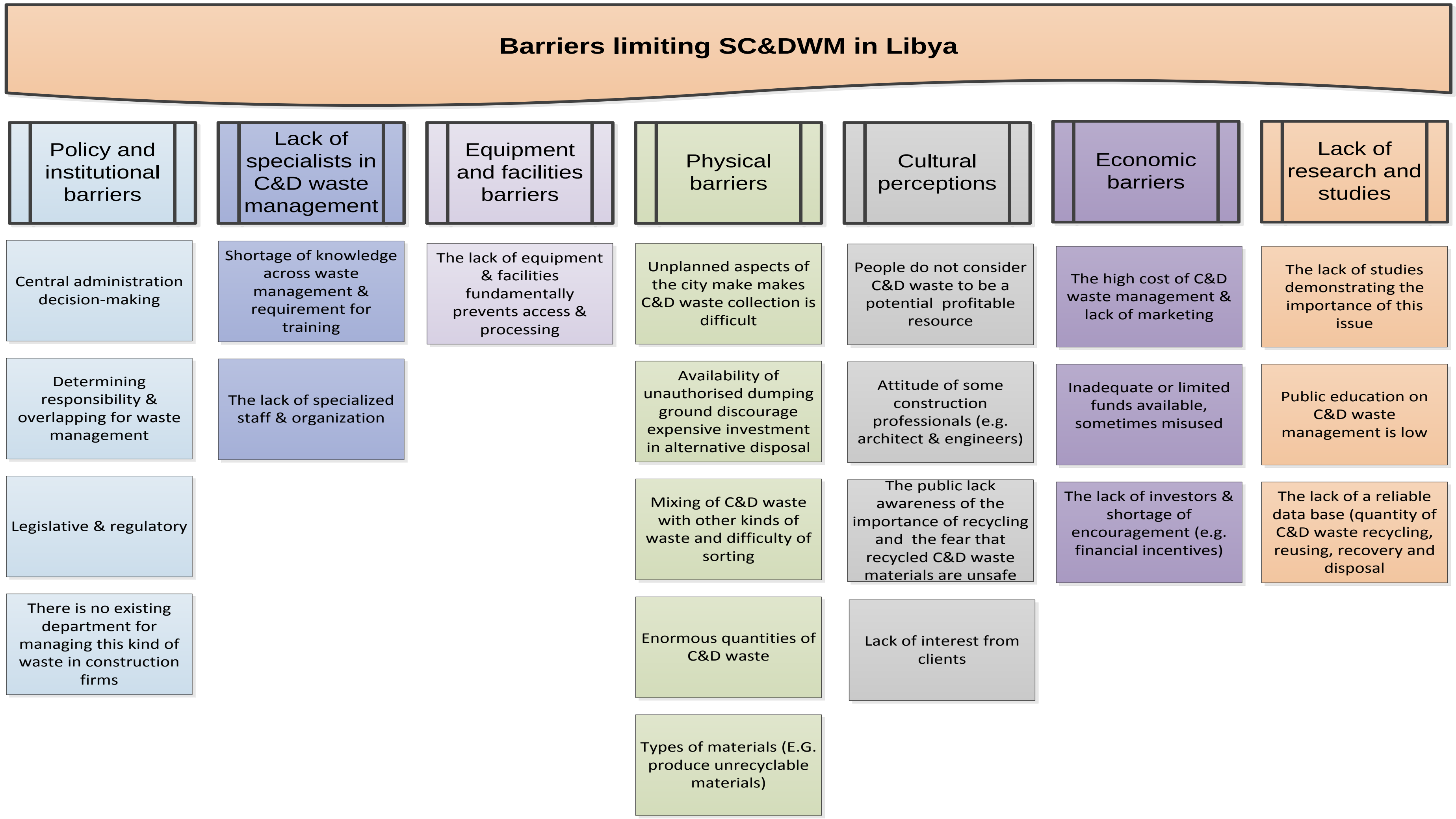


Figure 7-5: Barriers affecting SC&DWM in Libya

7.5 Recommended Strategies for SC&DWM

Following the first step of this FGD a brief discussion was included on current C&D waste management in Libya, also identifying barriers in several categories. The second step was focusing more on the barriers and proposing best practicable strategies for the Libyan government to obtain greater efficiency in C&D waste management, with the assistance of post-it notes and drawing materials for mind mapping. The participants were requested to list identified barriers and propose suitable strategies to achieve SC&DWM (see Figure 7.6).

Figure 7-6: Participants propose strategies to overcome the barriers

Table (7.2) summarises the identified barriers affecting the implementation of SC&DWM in the Libyan context and handy strategies to obtain C&D waste management in a sustainable manner. FGD also recommended that the area should be free from any abandoned munitions and unexploded ordnance before starting any type of C&D waste management, especially when this type of waste is resulting from conflict. Some successful factors were mentioned as extra supporting elements to implement SC&DWM in Libya, such as the availability of financial resources and the economic return, relating to the fact that most C&D waste comprises recyclable materials, and it is possible to re-use them in the reconstruction of Libya, while meeting the desire of citizens and government to dispose of waste properly.

Table 7-2: Barriers affecting SC&DWM in Libya and strategies for overcoming barriers

Barriers to best practise	What can be done to overcome barriers
1. Central administration and decision-making (1) 2. Determining responsibility for waste management in Libya is the most immediate obstacle to take advantage of this waste (4) 3. There is no existing department for managing this type of waste in construction company level (5) 4. Legislative and regulatory obstacles (2) 5. Shortage of knowledge across waste management and requirement for training (7 &15) 6. Lack of specialised staff and organisations (7) 7. Lack of equipment and facilities fundamentally prevents access and processing (3,8,17 &18) 8. Unplanned aspects of the city make construction waste collection and control difficult (9) 9. Availability of unauthorised dumping grounds discourages expensive investment in alternative disposal methods (10) 10. Mixing of C&D waste with other kinds of waste and difficulty of sorting (11) 11. Enormous quantities of C&D waste (12 &13) 12. Types of material (e.g. produce unrecyclable materials) (14) 13. People do not consider PCW and C&D waste to be a potential profitable resource (12 & 15) 14. Attitude of some construction professionals such as architects and engineers (7 ,15 & 19) 15. The public lack awareness of the importance of recycling and they fear that recycled construction materials are unsafe (15) 16. Lack of interest from clients (15,16,17 &18) 17. The high cost of for C&D waste management and lack of market competition (12 &16) 18. Inadequate or limited funds available, sometimes misused (17) 19. Lack of investors and shortage of encouragement (e.g. financial incentives) (16,17 &18) 20. Lack of studies demonstrating the importance of this issue (19) 21. Public education on construction waste management is low (15) 22. The lack of a reliable data base (quantity of C&D waste reusing, recycling, recovering and disposal) (6 &19)	1. Giving the right to municipalities to prepare schemes in line with the current situation with the possibility of direct contracting 2. Review of existing laws on waste and issuing executive regulations 3. Greater political will on the part of government to undertake projects as planned. 4. Review institutional framework for waste management. (e.g. EGA to collaborate with other government departments such as ministry of local government, municipalities and the relevant institutions) 5. Convincing construction companies of the importance of establishing a new department for managing C&D waste 6. Enforcing construction companies and municipalities to establish department to manage C&D waste and provide data about quantities and components 7. Preparation of workshops and training sessions for employees in this sector 8. Infrastructure development and provision of mobile plants to crashing and recycling C&D waste 9. Enforcing strict laws to prevent haphazard construction and preparation; providing housing plans to avoid this problem 10. Issuing strict laws to ban those who dispose of C&D waste in unauthorised areas and encourage investment in alternative methods and facilities 11. Imposing C&D waste sorting at the site and denying entry to landfill if waste not sorted properly 12. Recycled C&D waste materials should be formally adopted to be used in construction activities or other works if it does not conflict with national standards 13. Impose quotas (i.e. percentage) of reuse, especially in the reconstruction process 14. Use of recyclable materials and non-violation of environmental standards 15. Increasing awareness using various media outlets, campaigns and inclusion in educational curricula. 16. Cancel taxes for investors in the field of waste management and tax natural materials producers. Awards can be another approach to attract clients. 17. Provide adequate funding for waste management authorities with supervision and monitoring 18. Encourage small-scale industries based on waste management 19. Funding and adopt such studies (e.g. by universities and research centres)

The number inside the brackets in the barriers' column indicates the proposed strategy in the second column

7.6 Conclusion

In general, the FGD session was a very helpful technique in terms of saving time and cost to evaluate the visions perspectives of a cross section of participants concerning the management of C&D waste. Table (7.2) shows an outline of the foremost results of the session. As per small number of discussants, the outcomes of FGD is finite and complementary to the main research techniques, but these outcomes additionally validate the results of the questionnaire survey discussed in Chapters 6 and 7. These findings inform the following chapters concerning the findings and discussion of the integrated framework and the conclusion and recommendations.

8 FINDINGS, DISCUSSION AND VALIDATION

8.1 Introduction

Chapters 6 and 7 have presented a detailed analysis of data gathered in the cause of this study with the purpose of addressing the defined objectives to inform the best SC&DWM. The analysis has highlighted numerous key findings used to develop integrated framework for SC&DWM, which supports the recommendations presented in Chapter 10. Therefore, this chapter discusses findings of this research in the form of an integrated framework to guide officials to reduce C&D waste and increase the rate of 3R. However, the degree to which the study findings can be depended upon rely on the validation procedures conducted in establishing its validity, therefore this chapter presents the validation procedure undertaken.

8.2 Review

As elaborated upon in this thesis, there is a clear dearth of research on SC&DWM (Ali *et al.* 2016). Drivers of the solid waste issue comprise a significant and a fast-increasing population and alterations in consumption patterns with economic development creases in development and urbanisation (UNDP, 2007; Economic Commission for Africa, 2009). At present, research and publications on C&D waste management are relatively limited except numbers regarding municipal SWM (El-Treiki, 2000; Gebril *et al.* 2010; Etriki, 2013; Gebril *et al.* 2013; Hamad *et al.* 2014). As a consequence, reliable information on C&D waste management in the country is limited and hard to unearth.

8.3 Potential Connection between PCW: Debris and SC&DWM

PCW is one of the most important challenges to disaster response in terms of safe C&D waste management (Chapter 4). Therefore, with a lack of clear framework to deal with such waste as well as C&D waste arising from normal construction activities, there is a great opportunity to develop a framework which can manage C&D waste arising from both general construction activities as well as conflict based on similarities in C&D waste management processes.

8.4 Barriers Affecting SC&DWM

Based on the results of the questionnaires survey (Section 6.16), 19 main barriers toward SC&DWM were identified (Table 6.56), while open-ended questions yielded another 15 barriers (Figure 6.15). All of these barriers were further grouped into seven main categories (Figure 7.5):

1. Policy and institutional barriers;
2. Lack of specialists in C&D waste management;
3. Equipment and facilities barriers;
4. Physical barriers;
5. Cultural perceptions barriers;
6. Economic barriers; and
7. Lack of research and studies.

How these barriers relate with each other and the degree to which they affect SC&DWM have been investigated in detail and the outcomes of the analysis introduced in Chapters 4, 6 and 7 of this research. This chapter interprets the importance of some of the results with regard to the conclusions that support recommended strategies for developing a framework for SC&DWM in the succeeding segments of this research.

8.4.1 Policy and Institutional Barriers

As stated by Saleh (2005), Eltriki (2013) and Gebril (2013), the current institutional and legal framework backing SWM in the Libya is obviously insufficient. A close evaluation shows that SWM the based on three main pieces of legislation: Law No. (15) in 2003, Law No. (13) in 1984, and Health Law No. 106 of 1973. None of these are particularly germane to dealing with the existential C&D waste crisis. For instance, Law No. (15) in 2003 is a general-purpose environmental law, not specific to SC&DWM. As such, these laws do not have the level of detail that might be required of a legislative instruments needed to manage such waste.

These deficiencies in legislation are considerably exacerbated by the way in which there are no obviously enunciated strategies for the achievement of the general sustainable waste management goals of Libya. All SWM institutions in selected cities currently do not have the capacity to enforce best practice C&D waste management in a sustainable approach. These shortcomings in legislation combined with intrinsic institutional incapacities and unwillingness to authorise existing legislative arrangements in a harmonious and diligent way comprise a noteworthy obstacle to obtaining more prominent efficiencies in C&D waste management. In addition, there is overlap among institutional bodies responsible for the planning and implementation of SWM, which results in inertia or the wasteful and inefficient duplication of efforts (Wilson, 2007; Zarate *et al.* 2008), as described in Section 3.5, squandering available human, material and specialised assets (Eltriki, 2013).

8.4.2 Lack of Specialists in SC&DWM

As reported by Abdel Allah (2000), the reasons behind the accumulation of solid waste in the urban area include the deficiency of experienced staff. Currently, the GEA is still not able to obtain it is aims and control the present contamination issues, chiefly due to the absence of practical staff and scientific studies (Saleh, 2005). In general, the effect is that the waste management institutions in the selected cities are manned by insufficiently trained and less educated staff.

8.4.3 Equipment and Facilities Barriers

Equipment and facilities also form a major barrier to SC&DWM. Previous studies (Saleh, 2005; Etriki, 2013; Gebrial, 2013) noted that there is a lack of equipment and suitability (Figure 3.5), and a shortage of facilities was mentioned by a number of researchers (El-Treiki, 2001; Saleh, 2005), and the most prevalent practice is dumping (i.e. fly tipping) solid waste in open sites (Section 6.8, Figures 6.10-6.12). Furthermore, due to the recent conflict, many facilities were destroyed, along with the general degradation of infrastructure.

8.4.4 Physical Barriers

The methods of C&D waste disposal are the most significant barriers affecting sustainable waste management in the cities (Section 6.7, Figure 6.9), with all types of waste being mixed and collected together without any type of segregation (Elfalah and Boargob, 2005; Saleh, 2005; Eltriki, 2013). Consequently, C&D waste separation is more difficult, thus more effort and funding is required to address the problem.

8.4.5 Cultural Perceptions Barriers

Every country has particular cultural attitudes that affect the adoption of knowledge, including technology and behaviour such as C&D waste management, and environmentally responsible activities as perceived by some cultures may be aberrant in others (UNEP/DTIE/IETC, 1996). There are particular financial and social predispositions and outcomes between developed and developing countries in technology adoption (Madu, 1989; Dunmade, 2002), and it is vital for developing countries to plan particular frameworks in light of their prevailing social, economic and environmental requirements, including in SWM policy making toward sustainable waste management (Wilson *et al.* 2004).

8.4.6 Economic Barriers

Many researchers have flagged the lack of funding for SWM authorities, particularly in developing countries (Lohse, 2003; Parrot *et al.* 2009; Bhuiyan, 2010). In this specific circumstance, many developing countries are to a great extent reliant on government revenues to finance the SWM department, and general inefficiency along with latent inertia regarding sustainable waste management often prevent any serious efforts (Wilson 012). As indicated by Lohse (2003) there is a crisscross between what is accessible to SWM authorities in terms of various financial assets and their use needs. An allocated fund for SWM in Libya is finite compared to with the financing in the other developing countries (Saleh, 2005). According to Eltriki (2013), government revenue is the main wellspring of subsidizing the SWM sector, bankrolling approximately 70% in normal circumstances, but the recent conflict has decreased the availability of funding for the sector, as well as directly damaging waste facilities and generating more waste, therefore there is an essential for alternative strategies, options and other sources of funding.

8.4.7 Lack of Research and Studies

It is observed that one of the major barriers to efficient and effective SC&DWM is a shortage of scientific research and information. Currently there is no operational scientific research or data management concerning environmental impacts and management, and a lack of reliable data on waste generation and characteristics, which is a consequence of a lack of education and research (Saleh, 2005).

8.5 Options Available for SC&DWM

Sustainable waste management principles take into account the environmental and economic effects any management choice would have before merging same within the management framework. As reviewed in Chapter 2 (Section 2.14) of this study, the best practice choices for SC&DWM in order of preference are: waste prevention/reduction, reuse, recycle, recovery and disposal (Figure 2.22). Having considered the character and accumulated quantities of C&D waste arising from regular construction activities and PC, prevention may not be feasible at least in the short term.

8.5.1 Waste Reduction

According to the results from the questionnaire survey analysis (Section 6.4), very low levels of knowledge and education on SC&DWM were identified in the selected cities. A low level of education on C&D waste management was found to be one of the main barriers to SC&DWM in the Libya (Section 6.16). To overcome this circumstance, a radical education programme targeted at waste reduction is seriously required as a crucial component of the SC&DWM technique (Read, 2001; Phillips *et al.* 2004). The US Environmental Protection Agency (2002) noted that waste reduction has great economic and business potential, and can increase productivity, corporate image, product quality and environmental performance. According to Ding *et al.* (2018), reduction management can minimise 40.63% of waste production effectively at the design and the construction stage. This includes for example, reduced design modification at the design stage, on-site sorting and material reuse at the construction stage.

8.5.2 Waste Reuse and Recycling/Recovery

Reuse or preparing for reuse is the second most favoured choice for waste management as stated by the waste hierarchy, followed by recycling/recovery. However, the results from questionnaire survey analysis (Section 6.4) highlighted very low levels of education on 3R, despite the possibility of C&D waste reuse, recycling and recovery. According to Taha *et al.* (2004), the quality properties of demolition waste indicate that it is attainable to reuse a portion of most materials from C&D waste to derive economic as well as environmental benefits. Indeed, a powerful recycling system is a crucial part of viable integrated SWM system that can be a vibrant economic sector in its own right (Rathi, 2006). A strategy document is required which will indicate a recycling strategy along with appointed objectives to be achieved over the short and long term.

8.5.3 Waste Disposal

The only remaining option for waste that cannot be salvaged by other means is landfill (Tchobanoglous *et al.* 1993; Daskalopolous, 1998a). According to results from the questionnaire survey analysis (Section 6.7, Figure 6.9) methods of waste disposal or landfill site management are in most cases extremely poor, with all types of waste mixed together and discarded in the same landfill, with no regard for sustainability. Properly managed landfill sites are to guarantee that waste that cannot be managed otherwise can be disposed of in sustainable manner (Zotos *et al.* 2009), but as found in this study Libyan landfill is generally ad hoc (i.e. in open spaces) and used as a first resort, with no concept of sustainability whatsoever.

8.6 Discussion of Research Aim

The outcome of the study is presented in Chapter 9. An integrated framework developed based on findings from the literature review, quantitative and qualitative data was developed and presented. The framework contains four main parts; input, strategies/activities, output and outcomes/impacts. The input is what the government needs to put into the system; the processes/activities are the interactions that occur to generate the desired output. In this case, the input is the application of sustainable waste management principles and what the government need to change in their waste management system, whereby the strategy is the selection and adoption of appropriate techniques to achieve this change, and the activity is appropriate techniques to achieve the strategy. While, the output could be early outcomes toward and facilitate achieving the main outcomes. The integrated framework also recommended the strategies that could be adopted in addressing any challenge to SC&DWM. Therefore, the adoption of this integrated framework was identified as prescribing changes to current institutional and legislative framework strategy to develop C&D waste management in Libya.

8.7 Research Validation

According to Mackey and Gass (2005) there are several kinds of validity, including content, face, construct, criterion-related, and predictive validity, besides internal and external validity, which are the most common areas of concern. Therefore, this chapter focuses on internal validity, external validity to validate research finding, and the technique to evaluate the proposed framework.

8.7.1 Internal Validation

Internal validity alludes to the degree to which the findings of a research are a function of the factor that the investigator means (Mackey and Gass, 2005). According to Garson (2016), internal validation ensures freedom from bias in the research study results. Internal validation is the process to ensure that evidences obtained from interviews and documentary are properly interpreted in an event where the researcher was not directly involved in the process (Yin, 2013). However, there is no universal blueprint endorsed by the literature for examining perfect internal validity (Ankrah, 2007). Internal validation could also be accomplished through proper research design, or the convergence of findings with related published research (Rosenthal and Rosnow, 1991; Ling and Liu, 2008; Garson, 2016). Therefore, it has been indicated in Chapter 8 that in the main, the findings are supported by the literature. Likewise, internal validation could be achieved via academic validation (e.g. conferences, journal papers, seminars, presentations and workshops). Therefore, academic validation was widely used to validate findings of this study. Thus, to upgrade its validity forums of workshops, seminars and oral and poster presentation also used. Conference and journal papers which are submitted to peer review were another process used to examine the study findings and grasp feedback and comments which were also combined in the research, such a process likewise helps to enrich research work and possibly improves its findings. A list of workshops, seminars and publications during the research process has been provided (see list of publications). In this study internal validity was also reached by presenting research findings during FGD (Chapter 7), and also during framework evaluation to selected participants so as to obtain their feedback through an evaluation interview (see Section 9.7.2.1)

8.7.2 External Validation

External validity defines the bounds to which the findings of the research could be generalised (Marczyk *et al.* 2005; Ling and Liu, 2008; Yin, 2013); in other words, the degree to which the findings of the research are not exclusive to the research populace (Mackey and Gass, 2005). External validation procedure is intended to increase trust in research finding and it is a procedure that transforms findings to knowledge (Brinberg and McGrath, 1985). It is important to remember that a prerequisite of external validity is internal validity. However, if a research is not led with watchful consideration regarding internal validity, it is difficult to attempt to generalise the findings for a bigger population (Mackey and Gass, 2005). Replication and convergence analysis are the main forms of external validation.

8.7.2.1 Replication

Replication is a reliability test for empirical research (Kerlinger and Lee, 2000), including case study investigations (Silverman, 2015). Research replication is mindful with defining whether the group of findings of the research from an investigation can be obtained at or imitated when the same tools, research design, and research approach are applied. In fact, it is impractical to have an accurate replication given that no two events are ever the same (Ankrah, 2007). Therefore, repeating the survey in this research will not expect that the same respondents would be willing to finish a same survey once more. Thus, replication methods were not applied in this research study due to mentioned reason, and also due to the time and financial constraints to which this research was subject. However, the reliability of the study findings is bolstered by the questionnaires having been properly designed and piloted on a sound methodological basis.

8.7.2.2 Convergence Analysis

Convergence analysis includes the application of several research methodologies or approaches to obtain the accord of research findings (Ankrah, 2007; Denzin, 2009). In this research, applying quantitative approach (questionnaire survey) and qualitative approach (focus group discussion) revealed considerable accord between the research findings from both approaches. Subsequently, this harmony was completely confirmed (as reported in Chapters 6 and 7). Respondent validation is another method to obtain convergence analysis validation by utilising the view of research participants, in order to confirm the validity of research outcomes (Silverman, 2006; Creswell, 2009), which is used to evaluate and confirm the transferability and workability of the proposed framework for SC&DWM as in the next chapter (see Section 9.7.1).

9 DEVELOPMENT AND EVALUATION OF FRAMEWORK

9.1 Introduction

Pursuant to aim of this research and the findings from the previous chapters, this chapter presents the outcomes of the research in terms of the development and evaluation of the framework for SC&DWM, discussing an integrated framework for using instruments to reduce C&D waste arising and increase rate of 3R. Therefore, this framework helps to improve C&D waste management and encourage producers to avoid or reduce C&D waste generation. The extent to which the framework is successful depends on its intrinsic worth and the extent to which it is applicable to the Libyan context. Therefore, the chapter also outlines the evaluation procedure used.

9.2 Opportunities of Combining Normative of Sustainable Management of C&D Waste Results of Construction Activities and PC

The study, particularly in Chapter 4, developed a conceptual framework to consider PC debris. Based on similarities found in the literature and lessons learned from previous cases, most processes of sustainable management of C&D waste arising from disaster or normal construction activities are mostly similar. Chapter 4, also developed a conceptual framework for managing C&D waste to help design the main questionnaires survey as well as provide the outline of Integrated framework. Therefore, this study found potential for producing a framework that can manage such wastes. Due to the lack of current SC&DWM as well as accumulated quantities of C&D waste results of construction activities and PC. Thus, there is a need to develop a framework to combine the solutions to manage such wastes.

9.3 Overcoming Barriers and Challenges

9.3.1 Barriers Identified

The main barriers were identified as shown in Figure (7.5). The quantitative research (main questionnaire survey) found that the greatest barriers are lack in the facilities of SC&DWM, lack of tax to control construction waste disposal, low public education on sustainable waste management, limited funds available and their misuse. This indicates that steps must be taken to deal with these barriers to accomplish the general advantage from implementation of managing C&D waste in sustainable manner.

The barriers have to be addressed in order to achieve the intended benefits. There are distinctive methods for dealing with the barriers to develop sustainable practice for C&D waste management.

Chapter 2 (Section 2.19) established that barriers hindering SC&DWM, particularly in developing countries, include: (i) economic, (ii) physical, (iii) political, (iv) operational, (v) psychological, and (vi) social barriers. Table (7.2) shows the results of FGD on the barriers that may hinder SC&DWM in the Libyan context and strategies to overcome them, which have been considered in the phases of proposed framework, while if any new barriers or challenges emerge during implementation complementary instruments or solutions to overcome these may be devised. This is why evaluation and reviewing steps are very important. However, success factors mentioned by FGD as the availability of financial resources and the economic returns, relating to the fact that most C&D waste comprises recyclable materials, and it is possible to re-use them in the reconstruction of Libya, while meeting the desire of citizens and government to dispose of waste properly have been considered in as external support for propose a framework for SC&DWM (Section 7.5). Figure (9.1) shows the fundamental principles that were used to attain the integrated framework in particular order with regard to achieving the desired objectives. These fundamental principles are discussed below.

9.3.2 Input

Figure (9.1) shows steps that governments and other organisations concerned with waste management need to implement in the waste management system. Based on the research findings, the main key inputs are capacity building, policy implementation and enforcement, and evaluation and reviewing.

9.3.3 Strategies

In order to obtain these inputs several strategies need to be applied. Based on previous literature and the research findings, Figure (9.1) suggests the main key strategies by which to achieve the inputs, which include: increased awareness, infrastructure development, staff, marketing and legislation.

9.3.4 Activities

Based on Figure (9.1) some activities should be followed to practically implement the strategies, including launching a media campaign to increase awareness, investment and government support, training professionals in waste management and the construction sector, tax breaks and reviewing existing legislation and issuing new regulations where appropriate.

9.3.5 Outputs

It is anticipated that implemented activities will result in several outputs in the short, medium and long term. Based on the literature and the data collected, Figure (9.1) shows the key expected outputs for adopting these activities, which include infrastructure development, increased awareness about SC&DWM, trained staff, revised institutional framework and increased rate of 3R.

9.3.6 Outcomes and Impacts

As seen from Figure (9.1), the anticipated outcomes and impacts will follow the previous stages. These expected outcomes and impacts were also based on literature and fieldwork carried out. Therefore, as shown in Figure 9.1, the expected outcomes are job creation, economic improvement, a new energy resource, and reduced landfill site. Moreover, a numbers of positive impacts result from the implementation of the suggested strategies.

The main expected impacts are maintaining health, wellbeing and general appearance, minimising negative environmental impacts and the conservation of natural resources. All of these contribute to the main goal of SC&DWM.

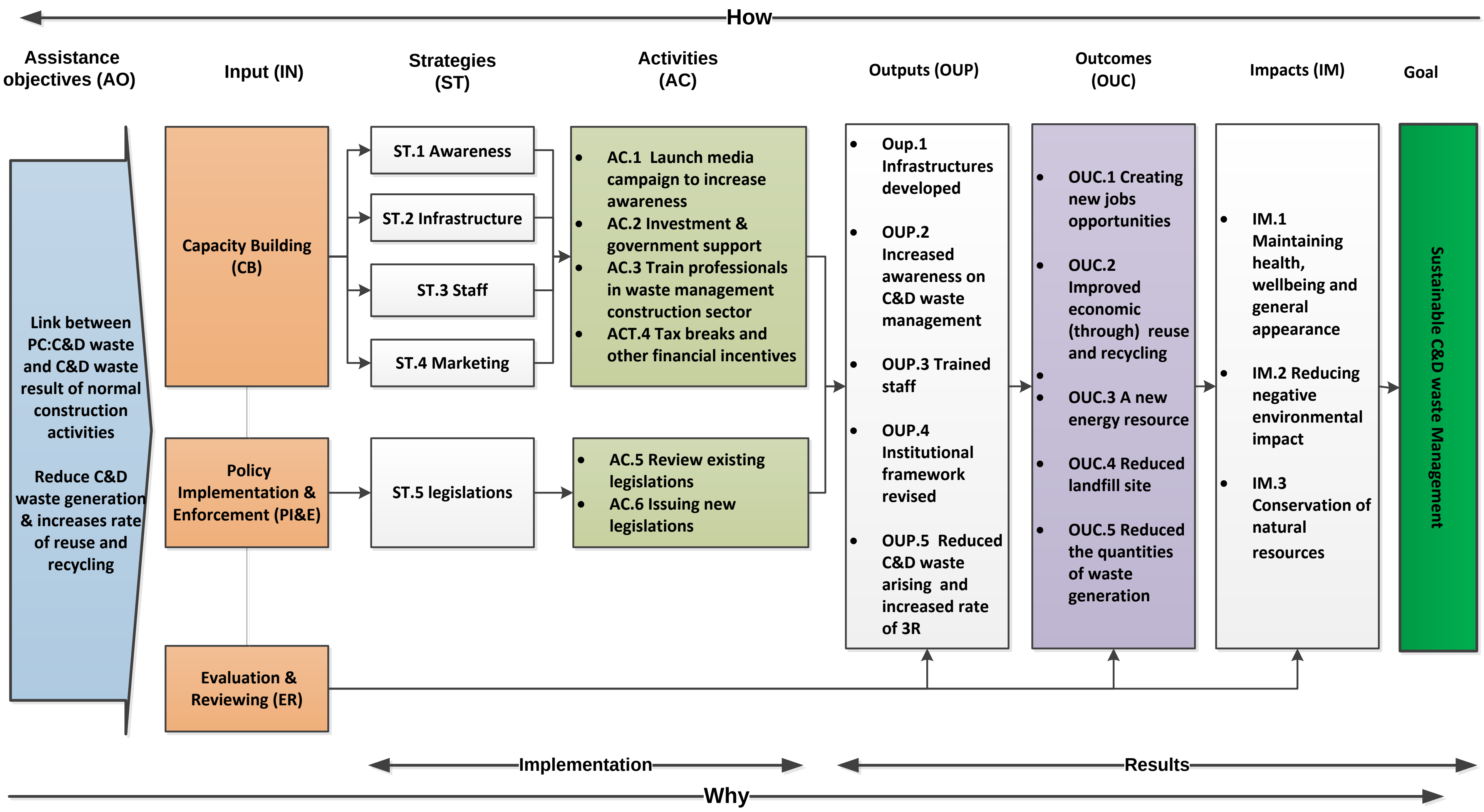


Figure 9-1: Vital structure principles for planning the framework for SC&DWM

9.4 Toward an Integrated Framework for SC&DWM

Both descriptive and prescriptive aspects are used in framework design. The framework describes the underlying structure needs of adopting SC&DWM, but it is also intended to enlighten decision makers about how they could improve SC&DWM. The framework addresses four main stages of SC&DWM:

- Options available for SC&DWM;
- Capacity building;
- Implementation and enforcement; and
- Evaluation and reviewing.

Figure (5.4) (research design and data collection), which highlights the path and methods utilised in obtaining the framework destination in this research work, begins by identifying the research area and displays it as an iterative process in the literature review, which reveals insight into many hazy areas. Beside the literature the quantitative and qualitative methods adopted enable a thorough study to be used and helps buttress the points made. The main issues of current SWM, barriers that may hinder implementing SC&DWM and strategies to overcome these barriers were discussed. The correct sampling approach/size and response rate were used.

The literature discussions in Chapters 2 and 3 established that C&D waste practices in the UK and developed countries are more sustainable compared with those in developing countries, particularly Libya. Chapter 2 in particular demonstrated that enormous quantities of C&D waste are generated annually as a result of C&D activities globally. Current strategies adopted to address C&D waste have yielded expected results.

Though possible routes for SC&DWM adoption have been considered by looking at options available for SC&DWM contexts, capacity building, policy implementation and enforcement and evaluation and review could improve the sustainability of applied SC&DWM (i.e. the sustainability of SWM as an institutional change), but related practices have not been fully explored and there is a lack of empirical evidence on such applications (Chapter 3). It was to this end that the research was directed to developing a framework by which principle of sustainable waste management best practice techniques could be used to improve management of C&D waste in the Libyan context (see Chapter 2). In addition, the finding in Chapter 6 and 7 and the discussion in Chapter 8 were used. Therefore, it became evident that the development of a framework that captured the main strategies to overcome the barriers and solve this issue and achieve SC&DWM is indispensable.

9.5 Overview of the Essential Framework Inputs and Strategies

The integrated framework for SC&DWM is designed based on issues identified through the research to have influence on C&D waste management by using fundamental principles (Figure 9.1) were used to attain and help design the integrated framework in a particular order that helps to achieve the desired objectives. It shows the inputs, and strategies suggested to obtain final outcomes. Therefore, the framework proposed to develop C&D waste management and to overcome identified barriers may hinder adoption of SC&DWM. The main key steps to develop and overcome these issues are discussed in the following sub-sections.

9.5.1 Options Available for SC&DWM

As in other types of waste there are several options for sustainable waste management, of which the waste hierarchy is the best example, dealing with contexts where there are opportunities to avoid or 4R C&D waste prior to the last resort of disposal. Generally, it is difficult to avoid C&D waste, particularly PC/C&D waste. Therefore, 3R practices ought to be asserted in C&D acuities. Minimising C&D waste via 3R practices is a route forward to achieve SC&DWM particularly in expanding the lifespan of landfill (Ng *et al.* 2017).

9.5.2 Capacity Building

In order to implement SC&DWM, a number of steps were identified from the study finding. Lack of capacity-building efforts is a major barrier to SC&DWM. This include lack of facilities, awareness and marketing, which are major issue in many countries, despite the preparation of planning. These issues make capacity building unachievable. In order to develop capacity to manage C&D waste properly four steps were identified as in Figure (9.2): increase awareness, develop infrastructure, increase staff efficiency and develop marketing. The measures to be put in place for all these steps are discussed below.

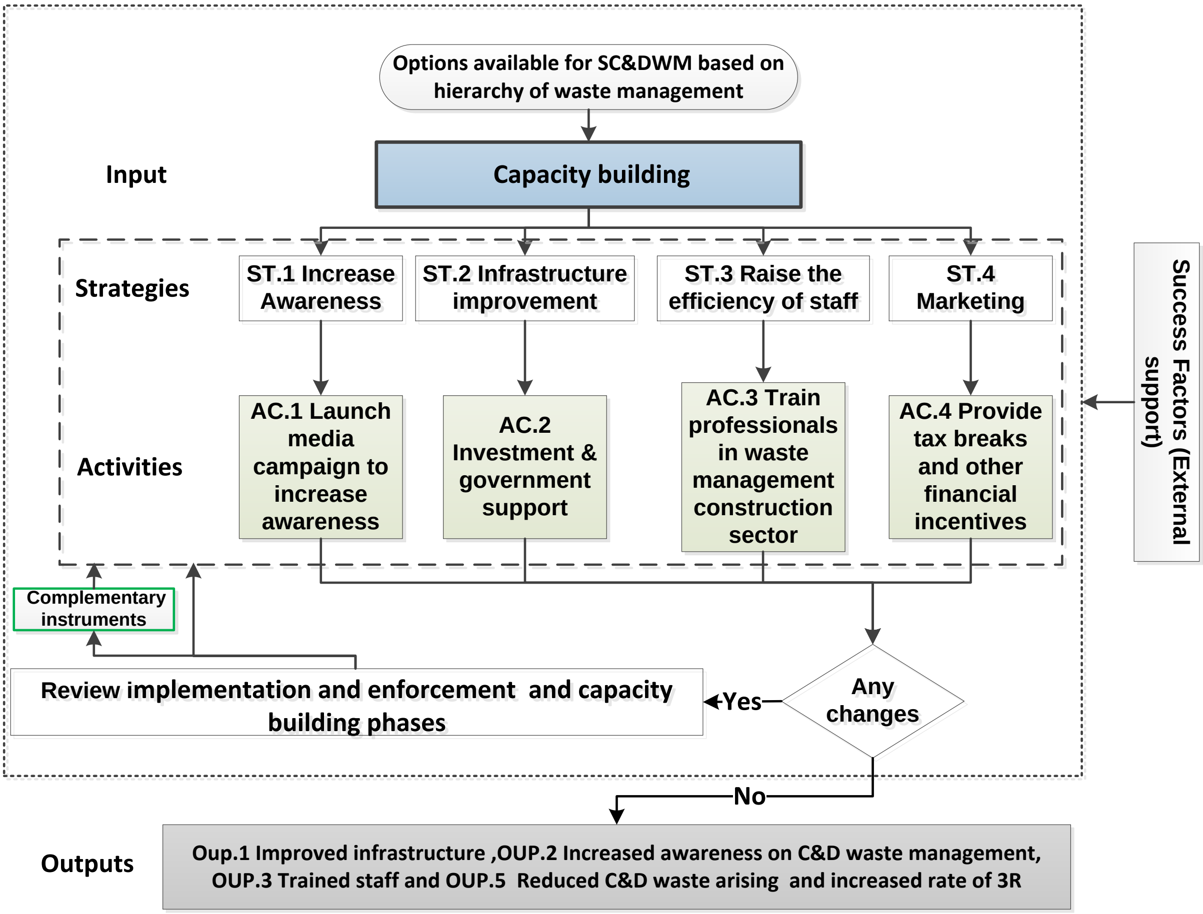


Figure 9-2: Capacity building framework

9.5.2.1 Increase Awareness

Increased awareness among stakeholders has been noted to be a key prerequisite for the successful integration of SWM in active practices (Lu and Yuan, 2011; Khalaf-Kairouz, 2017), which is the root of SC&DWM strategies based on this study's findings (Figure 6.13).

It is also identified as one of the most crucial success factors for managing C&D waste in general (Lu and Yuan, 2010; Lu *et al.* 2011). Therefore, there needs to be a continuing programme about the benefits of SC&DWM and the negative aspects of insufficient management using various media, workshops and campaigns. This is need to be fund by responsible sector and local and central Libyan government.

9.5.2.2 Infrastructure Improvement

Infrastructure is the foremost practical barrier to SC&DWM (Kien *et al.* 2013 and Lockreya *et al.* 2016), which one of the main barrier based on this study finding (see Table 6.56). Suitable waste reprocessing and treatment needs appropriately constituted infrastructure operated effectively for all steps of the waste hierarchy, in order to achieve efficient SC&DWM. Therefore, it is anticipated that the new infrastructures are needed to meet the new SC&DWM practices regulatory requirements. This is also need to be fund by responsible sector and local and central Libyan government.

9.5.2.3 Raise the Efficiency of Staff

According to research results the existing efficiency of SC&DWM staff is very poor. Therefore, workshops and training may the right ways to develop knowledge and skills, enable the acquisition of knowledge and improve the performance of individual staff members, as suggested by many researchers (Aguinis and Kraiger, 2009; Orr and Gao, 2013).

9.5.2.4 Marketing

For a successful SWM, secondary material market is significant (Huang *et al.* 2002). Chinda (2016) revealed that the market factor is the greatest influential factor in terms of C&D waste recycling decisions, and SC&DWM certainly fails if the market for the recycled material is not available (Lennon, 2005). In this study, marketing was mentioned as ae barriers or challenge that will face adoption of SC&DWM. Therefore, there it is a necessary to establish a market for recycled materials by mandating the use of these materials (particularly in construction activities); if the materials meet the prerequisite regulatory standards, and enforcing the sorting and (where applicable) recycling of such materials on the construction site. Thus, Libyan government must be invest in establishing support for C&D recycling at the legislative and regulatory level, with the potential for subsidies in this regard (e.g. loans and tax breaks to encourage investment), which is also a key solution to avoid illegal dumping and disposal by increasing the economistic benefits of recycling for waste producers (Duran *et al.* 2006; Wang *et al.* 2010). Increasing awareness also can be one of the key to accept C&D waste in the secondary materials market.

9.5.3 Policy Implementation and Enforcement

This research has recommended, a number of factors drive SC&DWM which must be taken into account if SC&DWM is to be achieved. One of the most important factors is policy implementation and enforcement. A policy for SC&DWM should include a group of aims or requirements to confirm the safe and efficient management of C&D waste. Policy is for the most part settled by the national government and may become codified in the national legislative framework. This policy should be pragmatic, considering the options available for SC&DWM and capacity building. The policy for SC&DWM should define the responsibilities of all parties and devise several strategies to achieve the desired target, which may comprise determining responsibility, processing strategies and enforcement planning. However, policy implementation could fail with lax methods of enforcement, thus warning letters, formal cautions, prosecutions and fixed penalties are necessary for violations of policy. The policy itself must undergo the following stages to implement and enforce SC&DWM appropriately there are necessary steps (strategy and activates) as in Figure (9.3).

9.5.3.1 Review Existing Institutional Framework and Legislation

Based on the results of this study, the institutional framework responsible for SC&DWM in Libya is clearly flawed. For example, there is an overlap of functions and lack of clarity of responsibilities and enforcement (see Sections 3.4, 3.5, 7.4.1, 8.4.1). In addition, successive changes have been made to restructure institutions without any prior scientific study.

There is also a flaw in the SWM legislation, especially on C&D waste, and a lack of operational details and regulations. Furthermore, most legislation is outdated and Libya needs pointers to re-evaluate, review and adapt legislation to current circumstances. Therefore, a review of these institutions is necessary to determine responsibilities in sustainable management and for enforcement of strategies to achieve the desired results. This is in line with the findings of a study in Tehran conducted by Nikmehr *et al.* (2017), which indicated that SC&DWM requires a review of legislation and regulations relating to C&D waste management and enforcement to ensure that they are applied correctly.

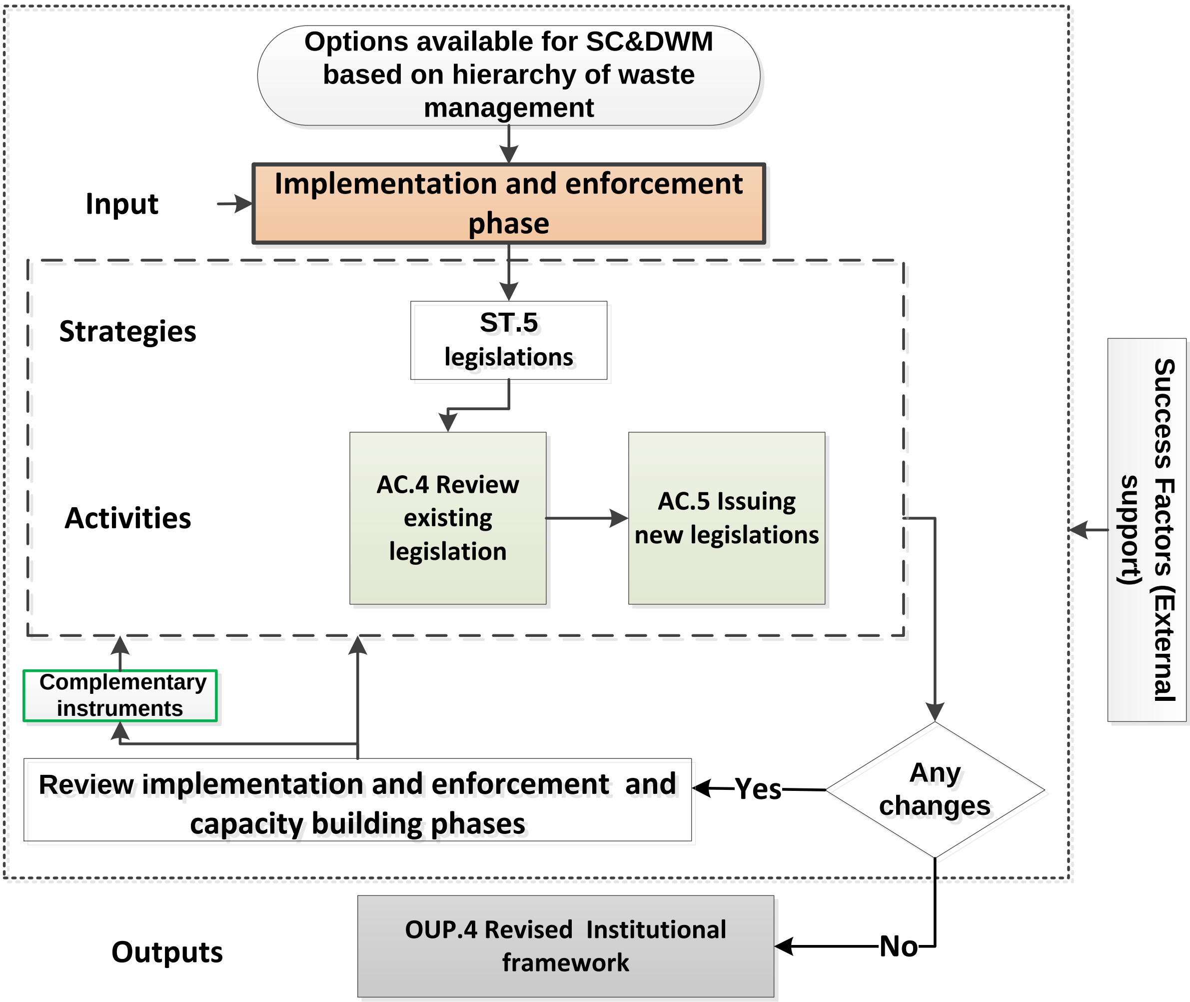


Figure 9-3: Implementation and enforcement framework

9.5.3.2 Issuing New Legislation

Legislations are always one of importance key strategy to sustainable waste management. This has been stated by many authors (Al-Hajj and Hamani, 2011; Adjei, 2016; Ajayi and Oyedele, 2017). The finding of this study was that legislation ranked as the third most important strategy in SC&DWM (see Figure 6.13). Therefore, issuing very strict legislation will be one of the main instruments to adopt and enforce SC&DWM. According to the findings of Ajayi and Oyedele (2017), six crucial measures are vital for waste management legislation and policy to successfully drive C&D waste reduction:

1. Tax incentives to high performers in waste management.
2. Enhanced design phases required in policies.
3. Sustainable design assessment systems should be extended by more points to proven waste performance measures.

4. Expanded strictness of administrative measures by requiring utilisation of demonstrated waste productive design, procurement and construction techniques.
5. Increased strictness of financial policies by increasing fines for deficient waste management.
6. Corroboration of approach requirements with empowering agents and facilitators.

9.5.4 Evaluation and Reviewing

The proposed framework evaluation and review is to confirm that the framework has attained the expected maximum influence towards SC&DWM. For instance, when any defect is found in the application process it needs to be reviewed. If it is not, the desired goal will not be achieved. Therefore, it shows that the timely evaluation and reviewing is important. Based on that, the process to develop can be given. Thus, it is necessary to review and revise policies and strategies in response to the dynamic market and national situation. The main aspects of the integrated framework are shown in the Figure (9.4), which used the outputs of framework for capacity building and revised implementation and framework as the main inputs.

9.6 Directory for Implementing the Framework for SC&DWM

Implementing the framework needs efforts from both the national government, local municipalities and related organisations, particularly C&D firms, both of whom must collaborate to actualise effective SC&DWM. Therefore, in order to obtain the required aim and make the most of the framework impacts of the framework and implementation, a directory that helps central government and related organisations has been proposed (see Table 9.1). This part of the framework identifies key stages that must be followed in order to apply and achieve the desired goal of reducing C&D waste generation, or rather to reach the best option of the waste hierarchy.

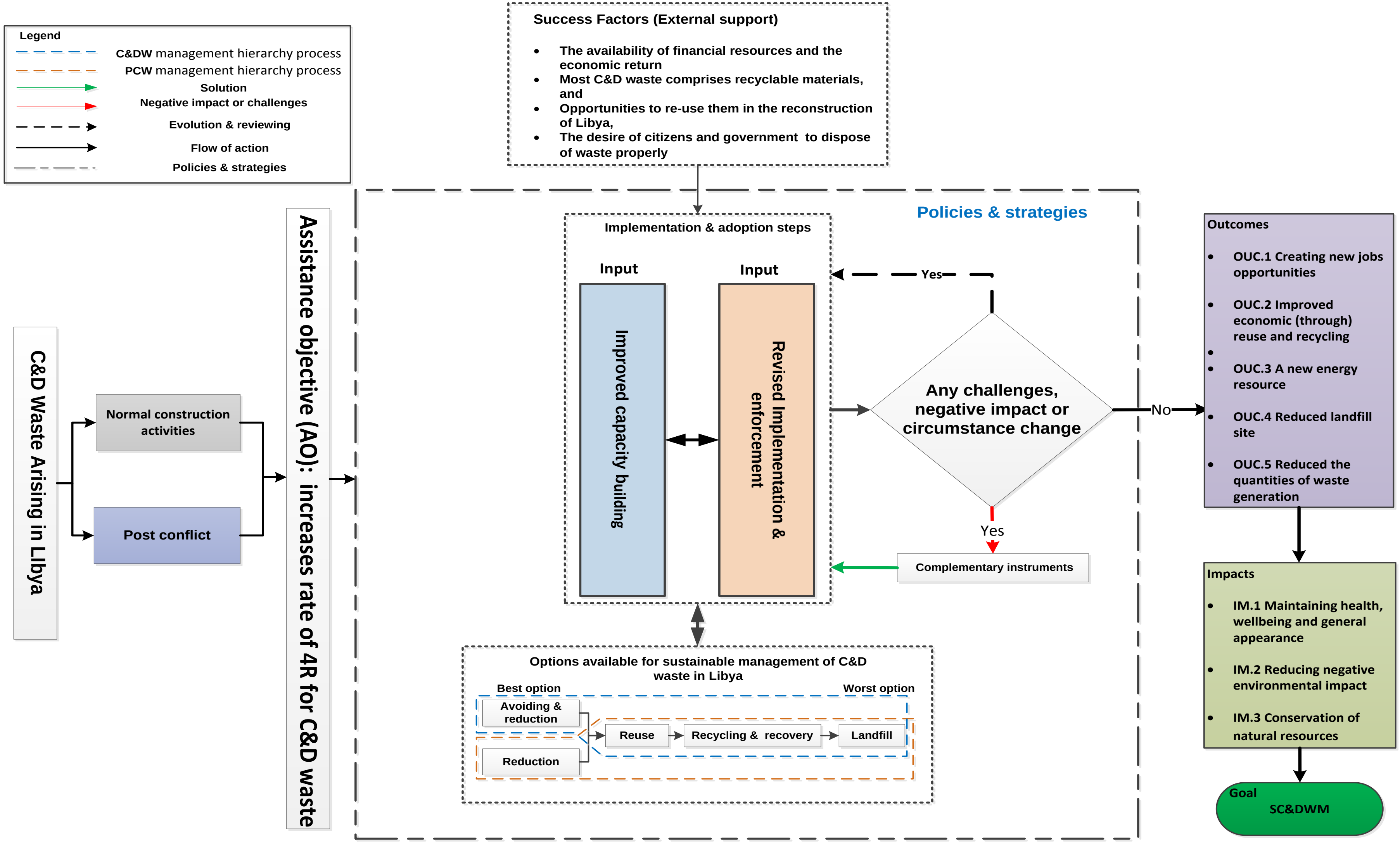


Figure 9-4: Integrated framework for SC&DWM

Table 9-1: Guide for implementation the integrated framework for SC&DWM

Strategies	Required work	Implementation
Capacity Building		
Increase awareness	Set up awareness on the benefits of SC&DWM	Attaining SC&DWM begins by creating awareness using various media outlets and campaigns.
Infrastructure and facilities improvement	Maintenance of existing facilities and establishing new facilities	Prepare a comprehensive study on the existing facilities and condition. Establishing new facilities to accommodate the quantity of recyclable materials resulting from PC and C&D works, according to the expected quantities. Governments establishing appropriate SC&DWM facilities at the proper time and in the correct location. Periodic maintenance and spare parts supply. Provide sufficient funding for SC&DWM authorities with supervision and monitoring. Government provision of mechanisms to promote investment in waste infrastructure (e.g. encourage small-scale industries based on sustainable waste management).
Raise the efficiency of staff	Set up training and education	Increasing efficiency of staff can be achieved by workshops and training sessions for different cadres of staff in this sector. Therefore, the government needs to first guarantee that its personnel and partners comprehend the principles of SC&DWM. Adopting international best practices to increase staff efficiency Guidelines of how C&D waste can be reduced and relevant risk assessment should be published Recruit qualified experts in this field. Awards and recognition can be another approach for raising the efficiency and performance of waste management in the construction sector.
Marketing	Humanizing a market for recycled C&D waste	Considerable time and money must be invested in solidification of relationships, keeping track of valuing alterations and becoming a trustworthy provider of materials. Tax breaks and other financial incentives for C&D waste investors and stakeholders promoting sustainable practices. Increasing awareness also can be another tool to humanise market for recycled C&D waste.
Policy implementation and enforcement		
Institutional framework and legislation	Review existing institutional framework and legislation	The team that is planning for SC&DWM should have comprehensive understanding of SC&DWM. Achieving SC&DWM starts with having a structure in place with determine responsibility to supervise sustainable waste management functions. Giving the right to municipalities to formulate schemes in line with the current circumstances with the possibility of direct contracting. EGA needs to collaborate with other government departments such as ministry of local government, municipalities and the relevant institutions.
	Issuing new legislation	Review of existing laws of waste management and issuing executive regulations. The legislation should take into account the factors affecting the environment in waste management process The legislations should prohibit starting C&D waste management works before risk assessment conducted. Government should issue legislation that have framed a market for building materials and products derived from the C&D waste flow. Government should issue legislation that force companies to use the C&D waste materials during reconstruction processes if the material compliance to Libyan materials standard and do not contain any hazardous materials. If C&D waste contain any hazardous substances, it must be managed or disposed in a sustainable manner.
Evaluation and reviewing		
Measuring the implementation process	Capture lessons learnt from implementing the framework	Review framework performance during implementation and at the end of projects, to help identify the framework's achievement on the desired objective. Review issues affecting the framework implementation. Capture lessons learnt and feed back to suggest solution.

9.7 Grounds for Framework Evaluation

The proposed framework was evaluated to ascertain its influence on C&D waste management development. This section discusses the justification for the evaluation and presents results from the procedure. As mentioned earlier, respondent validation was used to evaluate the proposed framework. The main objectives of evaluating the framework were to:

1. Assess the key elements and stages of the framework for SC&DWM practices in Libya
2. Assess that the framework covers all the steps needed to achieve SC&DWM practices
3. Assess the clarity of the framework and ease of use by practitioners
4. Ascertain from the participants that the framework is logical, relevant and workable

9.7.1 Respondent Validation

Respondent validation includes study participants reacting to types of preliminary data such as interview transcripts; keeping in mind the end goal is to check them for exactness, or the first drafts of interpretive reports (Bloor, 1978; Lincoln and Guba, 1985; Bashir, 2013). Respondent validation is normally connected with qualitative methods to deal with research, yet the issues raised are similarly applicable to quantitative and mixed methods strategies (Torrance, 2012). Additionally, some researchers of mixed methods approaches are progressively recognising the significance of involving the points of view of research respondents so as to represent these perspectives as completely and validly as possible (Christ, 2009; Mertens *et al.* 2010). Therefore, to evaluate the proposed framework, a subsequent interview with the respondents could be utilised; however, due to logistical issues pertaining to Libya during the period of the fieldwork (i.e. the security situation and frequent electricity cuts and poor internet connectivity) that inhibited conventional interview methods, questionnaire survey was used in this study.

9.7.2 Selection of the Participants

This research adopted mixed methods approaches (questionnaire survey and FGD), for which validity can be assayed by experts rather than in dialogue with other respondents (Torrance, 2012), which is similar to the concept of face validity approach where a group of experts or referees assess whether the measuring instrument measures the attributes of interest (Flood and Carson, 1993). In this context, the chosen participants were knowledgeable about SWM and construction activities. This enabled them to assess the framework on logical and comprehensive comment on its adequacy and clarity. They were also able to confirm that its input and output relationships are reasonable. The evaluation of the questionnaire was designed considering the criteria of comprehensiveness, applicability and logicality. In the questionnaire, experts (participants) could voice their comments on the framework (generally or with regard to specific aspects or phases). The expert participants selected for the convergence evaluation were among the respondents who participated in the main questionnaire survey and FGD. They had indicated their eagerness to learn about and take part in the results and outcomes of the study. They also had the relevant expertise, experience and academic/professional qualifications. A consent form was sent to the experts prior to the questionnaire being administered, reiterating the nature and purpose of the study (including a summary of the framework description and the flowchart showing the process of the framework in the vision). In it they were invited to voluntarily participate, and notified of their rights, including the right to refuse to participate, without this affecting their statutory rights (see Appendix 5). Participants were given time to familiarise themselves with and understand the framework. The questionnaire for validation was additionally attached to the email and an introductory letter, expressing the aim of the research, the evaluation procedure and what was anticipated from respondents (see Appendix 6). The backgrounds of the participants are summarised in Table (9.2).

Table 9-2: Background of participants for framework evaluation

Code	Position	Organisation	Background	Years of experience
P1	Assistant lecturer	Higher Institute for Engineering Professions (El Gubba, Libya)	Architect	6
P2	Director of the third-generation urban planning project	Architecture Consultative Office (Benghazi, Libya)	Architect	14
P3	PhD researchers on C&D waste management	School of Higher Technology, University of Quebec	No information	2
P4	Professor in environmental engineering and public health	University of Benghazi	Civil engineer	28
P5	Assistant lecturer	Higher Institute for Engineering Professions (El Gubba, Libya)	Architectural	5
P6	Director of projects and technical affairs	Assyed Mohammed bin Ali Assunusi University (Bayda, Libya)	Civil engineer	18
P7	Lecturer	Higher Institute of Construction and Building (Benghazi, Libya)	Civil engineer	10

9.7.2.1 Analysis of Participants' Responses

A total of seven questionnaires were returned, representing a 50% return rate from 14 questionnaires sent to architects, engineers, environment and waste management practitioners and academics who agreed to participate in this stage of the research. Table (9.2) shows the background of the participants. Responses from the participants from the procedures of the framework evaluation in connection to the rationale, relevance, workability and further matters of importance or recommendations which should to be included and/or considered in the framework proposed for SC&DWM in the country. These themes are discussed below based on participants' response to the evaluation questions. Therefore, in order to evaluate the appropriate of the framework to achieve SC&DWM, respondents were asked to indicate their level of agreement with the findings of this research to determine if the stages of the framework are appropriate to improve C&D waste management.

The responses were certain, with two respondents agreeing and three strongly agreeing that the framework is appropriate enough to obtain SC&DWM practices in Libya (see Figure 9.5), while one respondent was neutral and one was not sure. To clarify their views, the following comments support the evaluation of the findings:

> "In my opinion, the framework is appropriate to achieve SC&DWM However, some of the steps will have more impact compared to other steps in this framework". [P1]

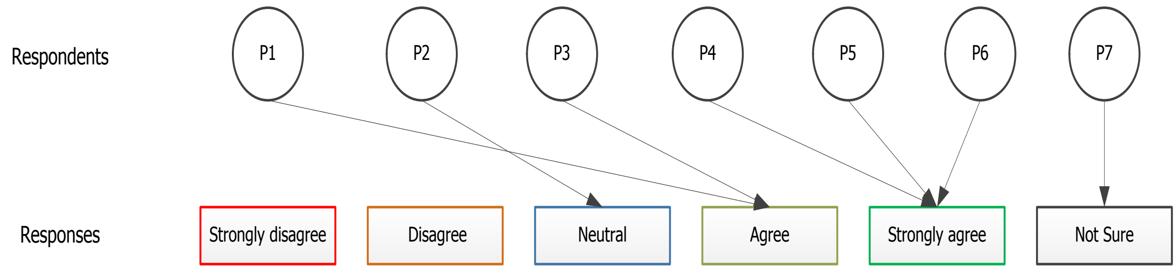


Figure 9-5: Responses if the framework appropriate enough to obtain SC&DWM practices in Libya

P3 considered that the framework considered all issues and solutions to obtain SC&DWM in Libya, while P4, P5 and P6 strongly agreed that the framework was appropriate to obtain SC&DWM in Libya, reflecting that the researcher considered all the current factors on the ground while designing the framework. However, two participants did not agree with the different way of responses, nature and not sure respectively:

> “In my view there is a difficulty in accepting legislation in Libyan society, which is an important pillar in this framework”. [P2]

> “There are no practices for C&D waste management in Libya”. [P7]

Keeping in mind the end goal (to assess if the framework addresses all steps needed to obtain SC&DWM), respondents were asked to indicate their level of agreement with the outcomes of this research and whether the stages of the framework were proposed to be covering all the steps to improve C&D waste management. Figure (9.6) shows that four of the respondents agreed, while one disagreed, one was neutral and one was not sure. In order to clarify views on the findings from Figure (9.6), one respondent made the following observation:

> “I am not sure if the framework covers all the steps needed to achieve SC&DWM practices in Libya, because this can only be confirmed if the framework is applied on the ground”. [P1]

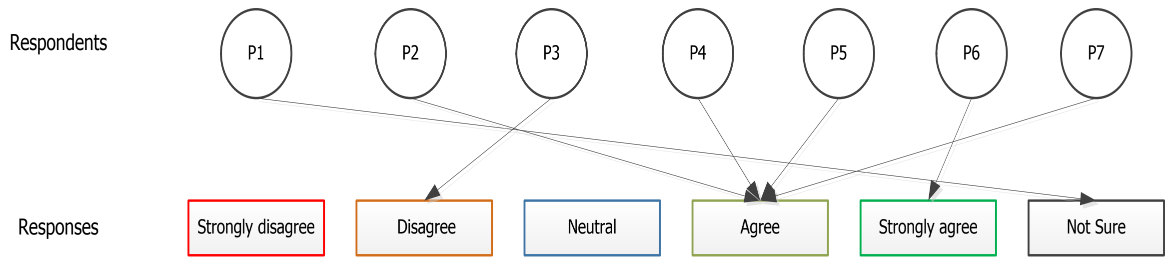


Figure 9-6: Responses if the framework covers all the steps needed to achieve SC&DWM practices in Libya

P2, P4, P5 and P7, agreed that the framework covers all the steps needed to achieve SC&DWM practices in Libya, while P4 and P6 agreed and strongly agreed (respectively).

> “The framework considered the circumstance in the ground. I think all the steps are in place to reach the desired goal”. [P4]

> “I strongly agree that the steps of the framework are designed in an integrated scientific way to address all issues in the ground”. [P6]

P3 disagreed that the framework covered the entire steps needed to achieve SC&DWM.

> "It is the future situation of the country that can determines if this framework covered all aspects needed or not". [P3]

While it is vital to emphasise the validity of the outcomes of this study, it is equally essential to evaluate the relevance of the framework developed to achieve SC&DWM in Libya. In order to achieve this goal, respondents were asked to assess the level of relevance of the framework to the Libyan context.

Figure (9.7) demonstrates that six of the respondents believed that the framework is relevant, while one considered it very relevant to the Libyan context. Likewise, in the previous questions, the following remarks were made by the respondents to buttress their own reasons on why the framework is relevant. P1, P2, P3, P4 and P7 all agree that the framework is relevant to the Libyan context, because it referred to important aspects related to the current situation of waste management in country.

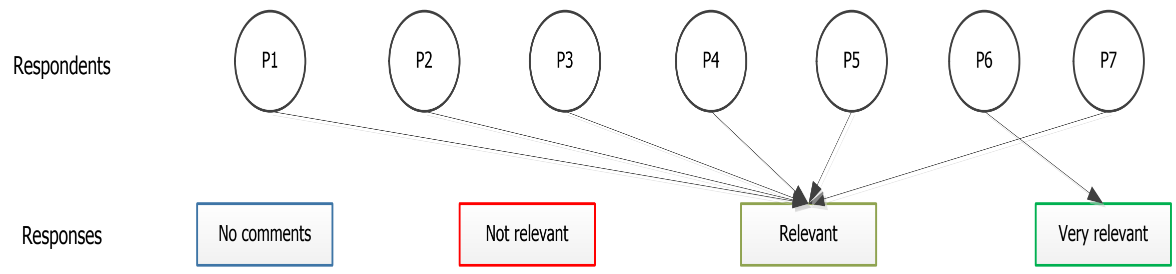


Figure 9-7: Responses on how relevant is the framework to the Libyan context

> "Yes, the framework is relevant to the Libyan context, and this was evident by demonstrating the sources of C&D waste in Libya and the way to deal with such waste; whether as a result of normal construction activities or post-conflict". [P5]

> "Yes, the framework is very relevant to the Libyan circumstances; the researcher did a very good job in understanding the current situation of Libya, by considering the most important barriers that may face SC&DWM and the way to overcome them". [P6]

Similar to the previous question, the respondents were asked to assess the level of logicality of the developed framework. Figure (9.8) shows that six participants responded to indicate that they found the framework to be logical, while one respondent agreed that the framework is very logical.

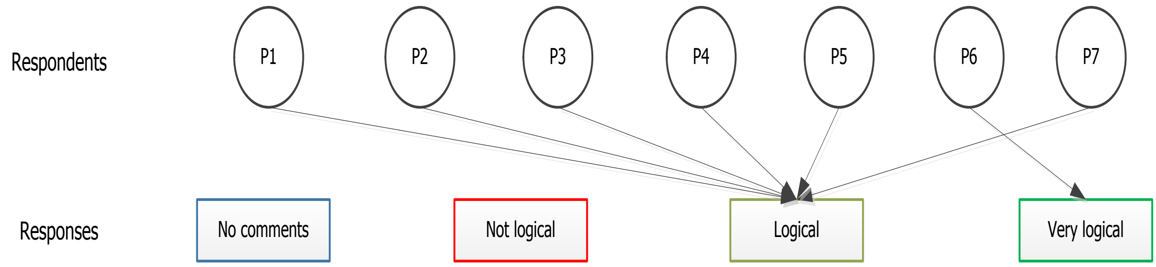


Figure 9-8: Responses on how logical is the framework

P1, P2, P3, and P7 all agree that the framework is logical, due to the series of proposed steps and sequence toward SC&DWM. In addition, it clearly shows the barriers and appropriate solutions to overcome these barriers.

P4 and P5 both agree that the framework is logical, because it is clearly designed on a scientific basis on understanding the current state of C&D waste management in Libya.

> "Yes, the framework is very logical. From my point of view, the framework takes into account the most important points, e.g. capacity building (which will contribute significantly to the development of C&D waste management in Libya). This was achieved by using clear fundamental steps, such as adequate assistance objectives and suggested strategies to reach final outcomes". [P6]

From figure (9.9), responding to the question "is the framework clear and easy to understand?", most participants were of the opinion that the framework is clear and very easy to understand. On the other hand, one respondent was unsure and one disagreed.

P2, P3, P4, P5 and P6 considered the framework to be clearly designed by defining the target and how this target can be reached it. For example, when the proposed framework is dealing with capacity building or enforcement phases for SC&DWM, the framework explains every single step required to reach these goals.

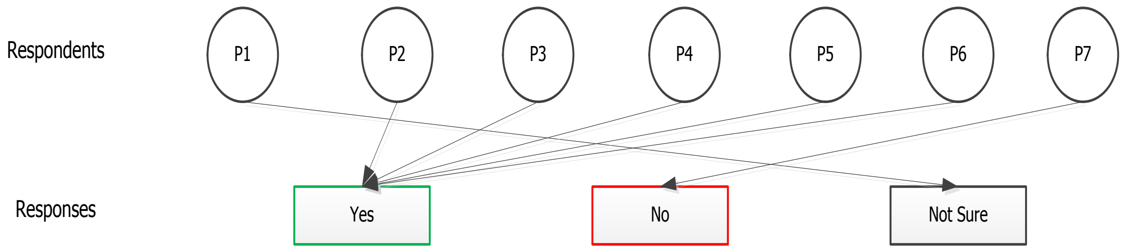


Figure 9-9: Responses if the framework clear and easy to understand

> "I am not sure if the framework is very clear and easy to understand. In my opinion steps like the use of complementary instruments need more clarification". [P1]

> "In my point of view, the framework would be easies understood by professionals". [P7]

Participants were asked their opinion about the description and layout of the framework. Figure (9.10) demonstrates that six of the respondents considered that the framework is comprehensive; while one respondent believed that the framework is adequate. Likewise, the accompanying comments were made by the respondents to support their view on the related subject.

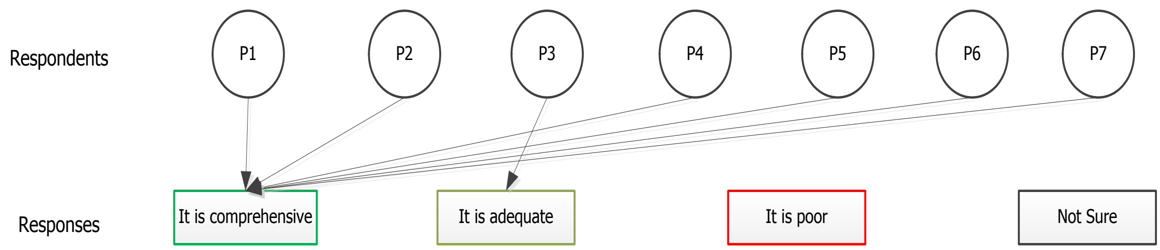


Figure 9-10: Responses on the framework description and layout

P1, P2, P3, P4, P5 and P6 considered the framework to be comprehensive, which they felt reflects that the researcher considered all the aspects in detail and the necessary steps to achieve SC&DWM.

> "In my opinion, the researcher has considered all aspects that may help to develop C&D waste management in a sustainable manner in Libya, especially when addressing the importance of a rising of awareness level of society and people involved in waste management". [P7]

In this section of framework evaluation the participants were asked if the framework is workable or not. Figure (9.11) shows that six of the participants agreed that the framework is workable, while one respondent was not sure. To buttress their opinions on their response, P1 and P2 considered that the framework is workable if all proposed steps were taken without exception, as reiterated below:

> "Yes, the framework is workable, because that the researcher has benefited greatly from best practices in this area". [P3]

P4 and P5 consider that the framework is workable if there is a real desire to adopt it among stakeholders.

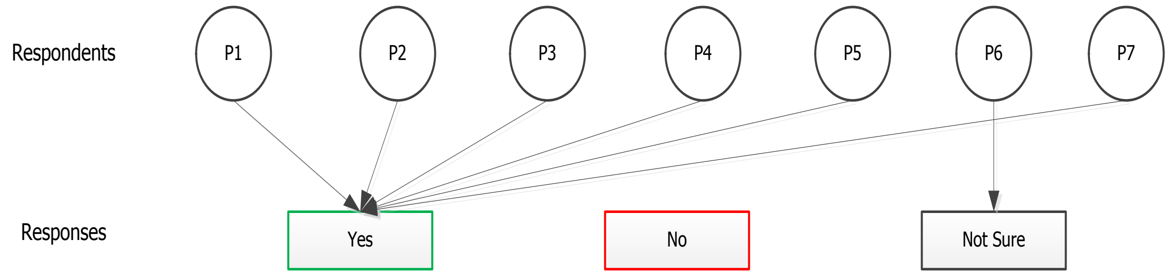


Figure 9-11: Responses if the framework is workable

> "I am not sure if this framework is workable, because it needs to combine a big effort from the institutions involved to reach satisfactory results, which I am concerned about". [P6]

> "Yes, Libya has many factors that make it workable." [P7]

In order to find out the view of the participants on how the framework could be easily implemented, participants were asked to indicate their level of agreement with the framework implementation guide in terms of whether (if followed) it will facilitate the sustainable management of C&D waste by government and related organisations. All participants were of the vison that if the framework is followed with the implementation guide it would definitely help the government and related organisations to reach SC&DWM (see Figure 9.12).

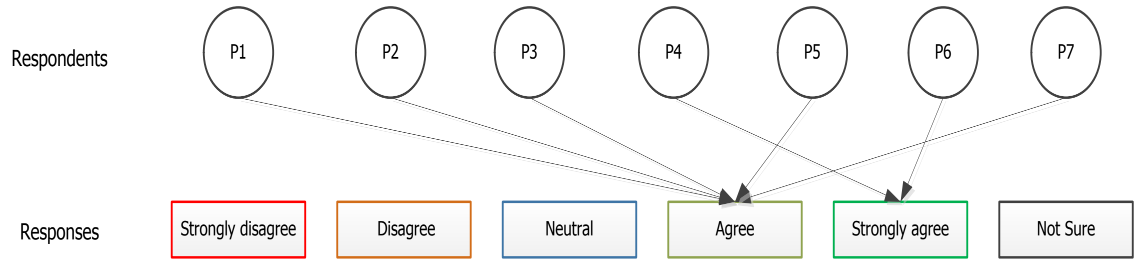


Figure 9-12: Responses on if the framework followed by implementation guide it will facilitate the SC&DWM by the government and related organisations

The following some remarks demonstrated their belief and why they chose these answers:

> "Yes, because it will explain in some details the steps that must be followed to implement it properly". [P2]

> "Yes, because it shows in detail what the government and related organisations need to do to implement the framework correctly and avoid missing any important action". [P7]

The last question in this evaluation process was to identify any further matters of importance or recommendations that should be included and/ or considered in the framework. Figure (9.13) illustrates that three of the participants were satisfied and believed the framework considers every issue and solution and it will make a big difference to C&D waste management.

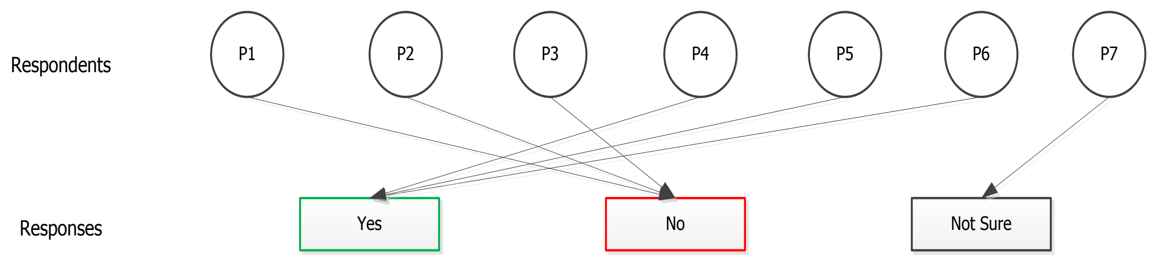


Figure 9-13: Responses if there any recommendations which should be considered in the framework

P1, P2 and P3 believe that the framework considers covers all important matters to achieve SC&DWM in Libya. On the other hand, three of the respondents (P4, P5 and P6) think that the framework may need to consider the following recommendations:

> "Yes, I think the framework needs to clarify in some detail how to activate the private sector to develop C&D waste management in Libya". [P4]

> “Yes, in my opinion, the framework needs to clarify in some detail how to deal with hazardous waste, if any”. [P5]

> “Yes, in my point of view, marketing is an important key to reaching the desired goal. My recommendation is if there any possibility to show how marketing of recycled C&D waste martials be developed in Libya” [P6]

One respondent was not sure, but generally positive:

> “I am not sure if the framework needs any further recommendation to consider. I think the framework is comprehensive and sufficient to achieve good outcomes”. [P7]

Besides evaluation of the framework, this section of the research also seeks to identify any recommendations that can help to improve the framework or other additional aspects that may need to be addressed. Albeit most of the recommendations above have been grasped by the framework, others have been flagged as areas for investigation by future studies.

9.8 Summary

The chapter has shown the main outcome of the qualitative and quantitative study findings. The chapter presented an integrated framework to obtain SC&DWM in Libya and presented framework validation based on experts’ opinions. The respondent validation was carried out to validate the framework. A questionnaire was sent to fourteen experts who participated in the main questionnaire survey or in FGD who were also willing to participate in the framework evaluation process. A total of seven questionnaires were returned, an equivalent of 50% return rate. Participants generally supported the study findings and believed that the framework is sufficient and could be used to develop C&D waste management. Moreover, the participants were of the opinion that the framework is appropriate for SC&DWM and relevant to the Libyan context. However, participants did make some additional recommendations that could be used to improve the framework. Although most of the recommendations made by the respondents have been captured in the framework, future study should also look at the additional areas specified by the comments.

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 Introduction

This chapter presents the conclusion of the research, epitomizing the degree to which this thesis has obtained its aim and objectives and recommending applications for practitioners and researchers. The chapter summarise the study findings, on the premise of which conclusions are drawn and the contribution to knowledge identified before making recommendations.

10.2 Fulfilment of Research Objectives

The objectives for this research are presented in Section 1.4 of Chapter 1. A total of five research objectives were framed to help achieve the aim of the study. All five objectives have been achieved through the application of a rigorous research design (see Figure 5.4). Table (10.1) summarises the methods applied in achieving each research objective and the chapters containing the evidence of such achievements.

Table 10-1: Methods used to achieve research objectives

Research Aim	Research Objective	Method of achievement	Chapter
To develop a framework for sustainable construction and demolition waste management (SC&DWM) to reduce, reuse, recycle and recover C&D waste.	To carry out a comprehensive literature review on C&D waste management in the global and localised context and barriers affecting the achievement of SC&DW in developed and developing countries.	Reviewed extant literature on C&D waste management in the global and localised context Reviewed extant literature on barriers affecting the achievement of SC&DW in developed and developing countries.	2 and 3
	To carry out a comprehensive literature review on PC/C&D waste management, in order to identify the main barriers and challenges facing managing such waste, as experienced in Libya	Reviewed extant literature and pilot study was conducted to identify the main barriers and challenges facing managing PC/C&D waste.	4
	To conduct an empirical assessment of current C&D waste management in Libya, and identify and assess the major barriers to adopting sustainable management practices and strategies to overcome by quantitative and qualitative approaches.	Undertook an empirical assessment of current C&D waste management in Libya, and identified the major barriers to adopting sustainable management practices using three questionnaire different groups and FGD.	6 and 7
	To develop and evaluate an integrated framework for SC&DWM in the Libya context.	Developed a framework based on questionnaires and FGD findings on C&D waste management practices in selected case studies and how to makes it sustainable. The framework was evaluated through respondent validation technique using questionnaire survey to obtain feedback from environmental and construction sector experts.	8 and 9
	To provide a range of targeted recommendations for SC&DWM in Libya so as to achieve greater efficiency and recommend directions for further research.	Outlined the main conclusions of the study and its contribution to theory, methodology and practice. Discussed recommendations for practice as well as future research suggestions that derived from the study's limitations.	10

10.3 Summary of the Research Findings

This research has empirically explored the current situation of C&D waste management in Libya. The research found that C&D waste management is very poor and there is an overlap and lack of clarity in the distribution of responsibilities. However, before summarising findings relate to Libyan context, the research findings about how SC&DWM can be achieved should be accorded due regard. The research noted that some strategies and instruments that can be used for the SC&DWM include economic, informative and administrative instruments, which may fail due to some barriers. MANOVA indicates a strong, statistically significant variation between and within the four respondent groups in levels of knowledge on key SC&DWM subjects (e.g. waste minimisation, ruse, recycling and recovery). An assessment of respondents' show that GPiE&WM had the highest understanding of C&D management. On the other hand, the policy makers group had the worst understanding of C&D waste management. To overcome such differentials, post-hoc test recommends an appropriate programme targeted at SC&DWM processes in Libya. The majority of respondents state that there is no specific strategy for managing C&D waste.

The majority of respondents said recycling is the best approaches for C&D waste management in the country. In addition, respondents favoured public-private partnerships, as the best option to manage C&D waste. An assessment of respondents shows that there is a difference between cities in who is responsible for C&D waste collection and transportation.

The research analysed some barriers as well as the main strategies that can be used to attain SC&DWM. Based on grand mean values, shows the orders of these barriers by request of importance. Therefore, the most important barrier limiting SC&DWM is lack of SWM facilities, while the least important barrier by order of absolute mean values is producing unrecyclable materials. Also, an additional 15 barriers were mentioned by respondents. For instance, security and stability of the country and central administration and decision-making mentioned as the main additional barriers. The research equally analysed the strategies that can be used to attain SC&DWM. Outlined results from MANOVA on the main strategies that may help to obtain SC&DWM in country. These strategies were categories by order of importance (grand mean values). It can be seen that the most vital strategy to SC&DWM is increasing awareness. On the other hand, the least important strategy by order of absolute mean values is establishing a new sector responsible solely for C&D waste management. Also, an additional 10 strategies were recommended by respondents. For example, Investment and cooperation with specialised companies have a long trading in this area pointed five times.

10.4 Concluding Remarks

This research has reviewed the current C&D waste management practices in the UK as an exemplar of best practices in developed countries to identify the universal requirements for SC&DWM in terms of waste policies and strategies. The literature indicates that C&D waste practices in the UK and developed countries are more advance compared with those in developing countries. It is clear that developing countries who desire to attain SC&DWM need to develop their legislative and institutional systems as the fundamental reference and provenance for the establishment of effective waste frameworks and policies.

Most of the policies and strategies for SC&DWM currently fail due to the fundamental disconnect between government (particularly legislation) and C&D stakeholders. The most important issues include inefficient management processes, lack of public awareness and involvement and insufficient facilities. Going by the results of this study, it is apparent that the C&D waste management system is inefficient and poorly organised. Local inhabitants, government and organisations related to waste management are not satisfied with the level of performance of C&D waste management. The accompanying conclusions arrived at from this research are as follows:

- A Chi-square test indicates that there is a relationship between and within the between education level and knowledge of understanding C&D waste management.
- Analysis of C&D waste collection and transportation showed there is a difference between cities in who is responsible for C&D waste collection and transportation.

- Analysis of performance practices indicates poor C&D waste management in general and level of environment consideration in waste facilities is very poor.
- FGD and analysis of the most common practice of C&D waste disposal in the three case studies identified open dumping or burning in open sites with other types of waste without any kind of waste management process.
- The main reason for the disposal of C&D waste in open and/or unauthorised sites are the absence of penalties followed by a lack of SC&DWM facilities. Inadequate information about the risks of dumping C&D waste are the last reason.
- Analysis of who is best equipped to manage the C&D waste problem showed that association between government and the private sector is the most significant strategy.
- There are no specific strategies for reducing C&D waste at organisation level.
- The key barrier to SC&DWM in Libya is the lack of SC&DWM facilities. On the other hand, the least vital barrier limiting SC&DWM in Libya was perceived to be the attitude of some construction professionals, such as architects and engineers, and types of material, for instance to produce unrecyclable materials.
- FGD grouped these barriers into seven main categories: policy and institutional, specialists in C&D waste management, equipment and facilities, physical, cultural perceptions, economic and research and study barriers.
- FGD indicated that the most important success factors affecting SC&DWM were the availability of financial resources and the economic returns, relating to the fact that most C&D waste comprises recyclable materials, and it is possible to re-use them in the reconstruction of Libya, while meeting the desire of citizens and government to dispose of waste properly.
- The main strategies to achieve SC&DWM management are increasing awareness of the negative impacts of construction and the positive influence on the economy, environment and society by campaigns and social media. On the other hand, the least vital strategy is establishing a new institution specifically responsible for SC&DWM.

The findings of this research were utilised to proceed to an integrated framework to direct policy makers and related organisation on C&D waste to achieve SC&DWM.

The framework can be adopted by policy makers and related waste management organisations as a system for promoting the sustainable management of C&D waste. Furthermore, the framework shows the opportunity of combining sustainable management of PC/C&D waste and C&D waste from normal construction activities in the Libyan context.

10.5 Contribution to Knowledge

Based on previous literature and the empirical findings of this study, it is apparent that the current framework of managing construction waste in Libya is moribund, inactive and unfit for purpose. Consequently, there is a requirement for a workable instrument which can be applied to develop C&D waste systems in the countries. This is the main target of this study, which has been attained. Therefore, the actions conducted in this study have offered contributions to C&D waste management and academia. The main contributions are described below.

10.5.1 Theoretical Contributions

- In view of the comprehensive approach of this study, the results have been used to develop an integrated framework that meets the main key features and steps to achieve sustainable management for construction waste arising from both PC and normal construction activities. This contributes to the knowledge on construction waste by providing a structured and cohesive framework for achieving SC&DWM results of both PC and normative construction activities, and provides a guide for framework implementation.
- This study has identified the challenges SC&DWM practice in contracting in the case studies and the strategies that could be used to address them.
- This research established the most vital success factors affecting SC&DWM are the availability of financial resources and the economic returns, relating to the fact that most C&D waste comprises recyclable materials, it is possible to re-use them in the reconstruction of Libya, while meeting the desire of citizens and government to dispose of waste properly.
- In this study two new definitions were proposed. The first definition considered all aspects of C&D waste and the evolving nature of construction management and technologies. The second proposed definition considered

the gap in existing definitions of solid C&D waste based on C&D waste sources.

- Previous studies recommend that waste management legislation is the most important factor to achieve SC&DWM. Many attempts have been issued to guarantee compliance with government legislation. However, the findings of this study indicate that capacity building is a necessary prerequisite before the legislative stage, including increasing awareness and infrastructure development, which could help individual and organisations (e.g. construction companies) comply with legislation. This reflects the reality of weak enforcement (and governance generally) and poor awareness of the importance of sustainability among C&D firms (and individuals) in Libya.

10.5.2 Methodological contributions

- As identified from the reviewed literature, research on C&D waste mostly relies on information from people directly involved in waste management or the construction sector generally. Since a large proportion of the general public is engaged in construction work, which usually includes renovation and demolition works, this study decided to take this public group into account. In addition, most of the studies on C&D waste have relied on only one case study (e.g. a particular city). This study used multiple case studies (three municipal areas) that represent the general types and sizes of Libyan cities. This method shows a methodological contribution that helps C&D waste to be inspected beyond the immediate construction level, with the capability to gather an integrated vision with other C&D waste stakeholders.

10.5.3 Practical contributions

- Practical contributions are also made by providing applied guidance for the Libyan government and other stakeholders in C&D waste management in Libya (especially policy makers) on how to achieve SC&DWM. This framework provides a better understanding of the requirements for SC&DWM, such as available options and capacity building. The framework could serve the following purposes:
    - A roadmap for Libyan government and policy makers in designing and implementing waste management strategy within the country; and

- A basis for improving and directing sustainable waste management training and education to inculcate factors that impact the result of C&D waste management endeavours.

10.6 Practical implications

The findings of this study present practical implications for Libyan central government, municipalities and organisations related to C&D waste management and society. These stakeholders need to have a clear and coherent vision in order to develop approaches and practices to achieve SC&DWMby conscious efforts to overcome identified barriers toward SC&DWM in Libya.

10.7 Recommendations for Practice

As expressed previously, C&D waste is poorly managed in Libya (in so far as it is 'managed' in any meaningful sense beyond dumping waste materials in desert open and areas), and according to the research findings there are numerous barriers to the sustainable management of such waste in Libya. Given these constraints, this research has provided and recommended a framework that could be implemented to achieve more prominent proficiency and sustainability with the following recommendations.

1. In order to achieve the main target of proposed framework, C&D waste management authorities (e.g. municipalities) should involve their staff in seminars, workshops or training sessions to obtain necessary knowledge, instruments and skills.
2. Awareness must be increased as the vital precursor to successful SC&DWM. Awareness schemes and events have to be arranged and they ought to include the concept of educating stakeholders about cost implications and the effect of insufficient SC&DWM over the long term.
3. In order to avert duplication and ineffectual overlap in responsibilities between authorities, a national waste authority and enforcement agency must be instituted with a defined organisational structure and clearly allocated roles for all stakeholders and personnel.
4. The legislative foundation for C&D waste management in selected cities is extremely feeble. This study thus recommends a comprehensive review of all legislative aspects relating to C&D waste management in Libya with a vision

to reinforce, harmonise and adjust them to the current circumstances and the ideas of the waste hierarchy.

5. The enforcement of a clear legislative approach with efficient financial strategies (e.g. tax breaks for compliant firms and landfill tax for others) can drive the adoption of SC&DWM practices.
6. The government should invest in the development of SC&DWM infrastructure as well as a master plan for developing infrastructure to adapt the new strategies required to guide future developments in waste management.
7. To assess the effectiveness of the new strategies, the objectives of these strategies should be determined on a short- and long-term basis.
8. Clear and brief definitions must be formulated and applied for various kinds of waste (including C&D waste) in order to investigate and plan waste policy and strategy.
9. The establishment of an official website containing the latest information regarding C&D waste (e.g. legislation, quantities and reports) would be beneficial for all stakeholders.
10. EGA needs to collaborate with the Urban Planning Authority and the Ministry of Housing and Utilities to prevent the haphazard construction, which makes it difficult to control and identify whereabouts and the accumulation quantities of C&D waste or to estimate quantities.
11. The experiences of developed countries should be considered, and investment and cooperation with specialised companies with a proven history of expertise in this area should be encouraged and facilitated by local Libyan firms and the government.
12. Construction companies should be persuaded of the significance of establishing internal departments for managing C&D waste.
13. To comply with new policy procedures, sufficient techniques and tools such as BIM need to be adopted by construction companies.

10.7.1 Recommendations for Further Research

The limitations of this research are presented in Chapter 1, Section 1.6 of which identifies the dimensions where more research is needed. Specific directions arising from the experience of this study include the following:

1. This research focused on the analysis of barriers currently facing SC&DWM. To be able to fully understand Libyan circumstances, the success factors identified during the FGD should be examined in more detail.
2. To achieve proper SC&DWM there is an urgent need for a study to identify the actual C&D waste quantity, composition and distribution in Libya by means of a comprehensive survey. This would entail facilitation and support from national and municipal authorities.
3. This research has looked at how the government could reduce C&D waste production and increase 3R. To be able to achieve SC&DWM, further studies on waste management at the construction industry level and the level of the waste management industry itself are necessary to explore the connections between pragmatic possibilities and government policy.
4. Further studies on adoption innovated techniques to reduce C&D waste in construction companies themselves are also crucial, particularly those demonstrating the potential economic benefits of sustainable practices, in order to incentivise the private sector and increase engagement with responsible initiatives.

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APPENDICES

Appendix 1A: Blank Copy of Questionnaire Used in Pilot Study

University of Wolverhampton
Faculty of Science and Engineering
School of Architecture and Built Environment
Wulfruna Street
Wolverhampton, West Midlands WV1 1LY
United Kingdom

Dear Sir/Madam

INVITATION TO PARTICIPATE IN PILOT STUDY: BARRIERS FACING SUSTAINABLE MANAGING C&D WASTE RESULTS OF POST-CONFLICT (PC) SUCH AS THAT IN LIBYA.

I am a research student at the School of Architecture and Built Environment (Faculty of Science and Engineering at University of Wolverhampton, UK) undertaking a Ph.D. research; the main The mine aim of the pilot study is to identify if there is any similarity on barriers facing C&D waste results of both PC and normal construction activities and conceptual framework development. It is being undertaken under the supervision of Dr David Oloke, Prof Craig Williamas Dr Chukwunonye Ezeah and Prof Jamal Khatib of the University of Wolverhampton. As part of my research I am undertaking a questionnaire based study exploring the knowledge of PC/C&D waste management in Libya. It would be very much appreciated if you agree to take part and complete this important pilot study. Therefore, we will be gaining your thoughts and opinion in order to develop a framework for sustainable construction waste management in Libyan context. However, the information you provide will give a massive contribution to develop construction waste management in Libya. Be assured that all answers you provide will be kept in the strictest confidential and the final results of the investigation will be obtainable upon your demand. Finally, we would like to thank you in advance for your kindly considerations and precious information. In completing the questionnaire you are consenting for your data to be used in the study. Please feel free to express yourself as much as possible, and you are free to discontinue your involvement at any time.

Ashraf Ali
(Principal Investigator)

Contact Details

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1.Respondents profile (Please tick [√] only one box)

Name of respondent (Optional) …………………………………………………….

Contact address (Optional)………………………………… Tel. (Optional) ……………………………

Gender

☐ Male ☐ Female

Occupation……………………………………………..

Years of experience

☐ Under 5 years ☐ 5-10 ☐ 11-15 ☐ 16-20 ☐ 21 and more

2.Please indicate if the following barriers affect sustainable PC/C&D waste management in Libya

	Yes	No	I don't know
The time to collect and process the materials	☐	☐	☐
Lack of specialists in PCW management	☐	☐	☐
Lack of specialised equipment	☐	☐	☐
The inability to physically separate the materials	☐	☐	☐
The lack of desire to offset raw material use in rebuild			
Unavailability of disposal sites	☐	☐	☐
Unavailability of markets to absorb large quantities of material	☐	☐	☐
Unavailability of markets to absorb large quantities of material	☐	☐	☐
Contractual arrangements	☐	☐	☐
Availability and feasibility of alternative waste management options	☐	☐	☐
Hazards in the waste matrix	☐	☐	☐

3.Please list other factors that could constitute barriers to sustainable Construction waste management in the Libya

Appendix 1B: Blank Copy of Questionnaire Used in Public Survey

University of Wolverhampton
Faculty of Science and Engineering
School of Architecture and Built Environment
Wulfruna Street
Wolverhampton, West Midlands WV1 1LY
United Kingdom

Dear Sir/Madam

INVITATION TO PARTICIPATE IN A STUDY: DEVELOPING A FRAMEWORK FOR SUISTAINBLE CONSTRUCTION WASTE MANAGEMENT IN LIBYAN CONTEXT.

I am a research student at the School of Architecture and Built Environment (Faculty of Science and Engineering at University of Wolverhampton, UK) undertaking a Ph.D. research; the main research aim is development a framework for sustainable construction waste management in Libyan. It is being undertaken under the supervision of Dr David Oloke, Prof Craig Williamas Dr Chukwunonye Ezeah and Prof Jamal Khatib of the University of Wolverhampton. As part of my research I am undertaking a questionnaire based study exploring the current knowledge of construction waste management in Libya. It would be very much appreciated if you agree to take part and complete this important survey. Therefore, we will be gaining your thoughts and opinion in order to develop a framework for sustainable construction waste management in Libyan context. This survey should take **15- 20** minutes to complete. However, the information you provide will give a massive contribution to develop construction waste management in Libya. Be assured that all answers you provide will be kept in the strictest confidential and the final results of the investigation will be obtainable upon your demand. Finally, we would like to thank you in advance for your kindly considerations and precious information. In completing the questionnaire you are consenting for your data to be used in the study. Please feel free to express yourself as much as possible, and you are free to discontinue your involvement at any time.

Ashraf Ali
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Section A: General information

A1: Respondents profile (Please tick [√] only one box)

Name of respondent (Optional) ……………………………………………………….

Contact address (Optional)……………………………… Tel. (Optional) ……………………….

Gender

☐ Male ☐ Female

Age

☐ 18-24 ☐ 25-29 ☐ 30-36 ☐ 37-43 ☐ 44 and more

Educated qualification

☐ Ph.D. ☐ Master ☐ B.Sc. /High diploma ☐ Other

Where do you live? (Please tick [√] only one box)

☐ El Gubba ☐ El Bayda ☐ Benghazi

A2:

1. Please identify your level of knowledge of the under listed construction waste management subjects **(tick √ correct response)**

	Excellent	Very good	Good	fair	Poor	Very poor	Not sure
Construction waste minimisation	☐	☐	☐	☐	☐	☐	☐
Construction waste reuse	☐	☐	☐	☐	☐	☐	☐
Construction waste recycling	☐	☐	☐	☐	☐	☐	☐
Construction waste recovery	☐	☐	☐	☐	☐	☐	☐

Section B: Operations

B1: *Construction and demolition waste generation and collection*

Please respond to the following questions relating to waste generation

2- Who is responsible for collection and transfer of construction and demolition waste? **(Please tick [√] all applicable options)**

☐ General Environment Authority ☐ Public Service Company ☐ Contractors ☐ Specialised companies

☐ Owner of the project ☐ Others please specify______________________

3- How would you rate the performance of waste management in terms of the level of

	Excellent	Very good	Good	fair	Poor	Very poor	Not sure
1-Construction and demolition waste reuse	☐	☐	☐	☐	☐	☐	☐
2- Construction and demolition waste recycling	☐	☐	☐	☐	☐	☐	☐
3- Construction and demolition waste recovery	☐	☐	☐	☐	☐	☐	☐

4- In general, how do you evaluate the state of construction and demolition waste management in Libya? (Please tick [√] only one box)

☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor ☐ Very poor ☐ Not sure

5- Are construction and demolition waste sometimes disposed with other types waste in the area where you live?

☐ Yes ☐ No ☐ Don't know

Section C: Waste policy and strategy

C1: Barriers for widespread adoption of sustainable construction waste management in Libya

Please respond to the following statements as honestly as possible (tick √ correct response)

6- Please indicate how the following barriers affect construction waste management in Libya.

	Very low influence	Low influence	Moderate influence	High influence	Very high influence
Waste policies lack clear strategies for action	☐	☐	☐	☐	☐
Laws regulating waste management are inadequate (Lack of Government Interventions)	☐	☐	☐	☐	☐
Construction waste management institutions are weak	☐	☐	☐	☐	☐
Unplanned aspects of the city make construction waste collection difficult	☐	☐	☐	☐	☐
Availability of dumping grounds discourages expensive investment in alternative disposal methods	☐	☐	☐	☐	☐
Limited funds available are sometimes misused	☐	☐	☐	☐	☐
Public education on construction waste management is low	☐	☐	☐	☐	☐
Waste workers are poorly trained and poorly paid	☐	☐	☐	☐	☐
Operational equipment are obsolete and insufficient	☐	☐	☐	☐	☐
There is no tax for control construction waste disposal	☐	☐	☐	☐	☐
Types of the material e.g. (produce unrecyclable materials)	☐	☐	☐	☐	☐
Encouragement e.g. financial incentives	☐	☐	☐	☐	☐
Different waste management service from one place to another e.g. City, town, village etc	☐	☐	☐	☐	☐
Lack in the facilities of waste management	☐	☐	☐	☐	☐
The lack of reliable data base (quantity of construction and demolition waste recycling reusing recovering and disposal)	☐	☐	☐	☐	☐
No review of waste management plans on a regular basis	☐	☐	☐	☐	☐
Lack of interest from clients	☐	☐	☐	☐	☐
Lack of market competition	☐	☐	☐	☐	☐
Attitude of some construction professional such as architects and Engineers	☐	☐	☐	☐	☐

7- Please list other factors that could constitute barriers to sustainable Construction waste management in the Libya

C2: Waste management strategy and environmental health (please tick √ correct response)

8- Waste facilities in Libya are at times located without proper environmental consideration?

☐ Yes ☐ No ☐ Don't know

09- The commonest method of waste disposal in my area is

☐ Sanitary landfills ☐ Open dumping ☐ Burning ☐ Incinerators

10- Some people dump construction waste in un- authorised places because

☐ No facilities ☐ Inadequate information about risks ☐ No penalty ☐ To save cost

11- Please suggest an environmentally friendly way to manage construction waste in Libya? (Please tick [√] only one box)

☐ Waste minimisation ☐ Recycling ☐ Energy generation ☐ Backfill materials

12- In your opinion who is best equipped to manage the construction waste problem in Libya? (Please tick [√] only one box)

☐ Government agencies ☐ Private organisation ☐ Joint government and private ☐ Individuals

C3: Suggested strategies to minimise C&D waste and expected outcome

13- Which of the following approach do you think could improve construction and demolition waste management in Libya?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Issuing very clear and strict legislations and regulations with enforcement to preventing construction and demolition waste.	☐	☐	☐	☐	☐
Establishing a new sector responsible just for construction and demolition waste management.	☐	☐	☐	☐	☐
Providing more funds to develop infrastructure construction and demolition waste management	☐	☐	☐	☐	☐
Increasing awareness of the negative impact of construction waste and shows the positive influence on Economy, environment and society by campaigns and social media	☐	☐	☐	☐	☐
Increasing the investment on recycling and recovery of construction waste and providing and providing marketing for these products	☐	☐	☐	☐	☐

14- What is the outcome of implementing sustainable construction waste management in Libya?

	Strongly disagree	Disagree	neutral	agree	Strongly agree
Providing new opportunities for jobs creation	☐	☐	☐	☐	☐
The economic benefits	☐	☐	☐	☐	☐
Increasing reuse, recycling & recover rate	☐	☐	☐	☐	☐
Reducing the quantities of waste generation	☐	☐	☐	☐	☐
Reducing in area for waste landfill	☐	☐	☐	☐	☐
Reducing negative environmental impact	☐	☐	☐	☐	☐
A new energy resource	☐	☐	☐	☐	☐
Maintaining health, wellbeing and general appearance	☐	☐	☐	☐	☐

ANY COMMENTS

____
____
____
____
____
____
____
____

Thank you for completing the questionnaire

Appendix 2: Consent Letter for Questionnaires Distribution

Consent Letter for Questionnaires Distribution

Title of study: **Development framework for sustainable construction waste management in Libyan context**

Lead researcher: **Ashraf Ali**
Ph.D. student University of Wolverhampton, UK,
School of Architecture and Built Environment and Built Environmental
Tel: 00441902322671
Email:A.Ali43@wlv.ac.uk
Assear2008@gmail.com

Supervision team: **Dr. David Oloke, Prof Craig Williamas Dr Chukwunonye Ezeah and Prof Jamal Khatib**
Email:D.A.Oloke@wlv.ac.uk

Dear Sir/Madam

I am carrying out a study on framework development for sustainable construction waste management in Libya, as part of a PhD research at the School of Architecture and Built Environment, Faculty of Science and Engineering, University of Wolverhampton, UK. I am conducting a questionnaire based study, exploring the current knowledge of construction sector and other related professionals in construction waste management. For the purpose of data collection, your organisation has been chosen to participate in this research and I will be grateful if you will grant me permission to distribute the questionnaires to your organisation's staff. In completing the questionnaires, you are consenting for your data to be used in the study. Be assured that all answers you provided will be strictly confidentiality kept. Please feel free to express yourself as much as possible, and you are free to discontinue your involvement at any time. We will appreciate receiving your consent for participation via email (A.Ali43@wlv.ac.uk). Thank you in advance for your kind consideration.

Yours sincerely

Ashraf Ali

Appendix 3A: Participant Information Sheet/Consent Form

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Title of Project: Development framework for sustainable construction waste management in the Libyan context

Name of Researcher: Ashraf Ali

I am writing to invite you to participate in a Focus Group Discussion (FGD) as part of my PhD research project, at the School of Architecture and Built Environment, Faculty of Science and Engineering, University of Wolverhampton, UK. I am undertaking the FGD to produce supporting data particularly from experts in order to reinforce quantitative data already gathered. The main research aim is to develop a framework for sustainable construction waste management in Libyan. You have been identified as an expert in one of the areas of interest that my research is covering from your work with relevant organisations. The FGD will last for between 60-90 minutes, where the discussion will be recorded. Please be assured that anything you say in the course of the discussion would be held in utmost confidentiality. All personal data will be anonymised to protect the identity of participants and any notes taken during the FGD would be destroyed afterwards. The FGD would take place at school of civil engineering, University of Benghazi. Once we have received your consent for participation, you will receive further details about the event nearer to the date. We will appreciate if you could complete and return a scanned copy of this consent form to (A.Ali43@wlv.ac.uk).

Thank you in advance for your kind consideration.

Please tick boxes

1. I confirm that I have read and understand the information sheet dated for the above study and have had the opportunity to ask questions. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time/up until commencement of data analysis without giving any reason. ☐
3. I understand that my data will be stored securely and confidentially and that I will not be identifiable in any report or publication ☐
4. I understand that the researcher may wish to publish this study and any results found, for which I give my permission ☐
5. I agree for my interview to be tape recorded and for the data to be used for the purpose of this study. ☐
6. I agree to take part in the above study. ☐

………………………..	……………………..	…………………………
Name	Date	Signature

Contact Details
Tel: ……………………………………… Emails………………………………………

Appendix 3B: Letter of Invitation to Participate in Focus Group Discussion

UNIVERSITY OF WOLVERHAMPTON
KNOWLEDGE ▪ INNOVATION ▪ ENTERPRISE

Title of study: **Development framework for sustainable construction waste management in Libyan context**

Lead researcher: **Ashraf Ali**
Ph.D. student University of Wolverhampton, UK,
School of Architecture and Built Environment and Built Environmental
Tel: 00441902322671
Email:A.Ali43@wlv.ac.uk
Assear2008@gmail.com

Supervision team: **Dr. David Oloke, Prof Craig Williamas Dr Chukwunonye Ezeah and Prof Jamal Khatib**
Email:D.A.Oloke@wlv.ac.uk

Dear <Name>

The University of Wolverhampton, United Kingdom, will be conducting a Focus Group Discussion **on Development of Framework for sustainable construction waste management in the Libyan context** on **January 17th 2017**. To assist in this work, the University will be consulting with people interesting in waste management and other stakeholders, to understand current construction and demolition management practices and analyse the barriers and success factors affecting the adoption of sustainable management practices. We would therefore like to invite you to take part in the discussion to be held at the class room number 11, Faculty of Engineering, University of Benghazi, on **January 17th 2017**. The discussion will start at 11am and finish around 1pm. Tea, coffee and light refreshments will be provided. The discussion will be hosted by a researcher from the University with segments to be led by experts in the construction and waste management sector whose role is impartial. Your identity will remain anonymous and you will not be personally identified in any subsequent reports. We will contact you by telephone again during the week before to confirm your attendance. We are sure that the group will result in a lively discussion, and will once more contribute to the enhancement and the enjoyment of your environment within Benghazi. If you have any queries regarding the discussions, then please contact 00441902322671. Thank you for your support, we look forward to seeing you again on **January 17th 2017**.

Yours sincerely
Ashraf Ali

Appendix 3C: List of Focus Group Discussion Participants with Contact Info

كشف المشاركين بحلقة النقاش

التاريخ: موافق:2017-01-21

المكان: كلية الهندسة المدنية جامعة بنغازي

الرقم	الاسم	جهة العمل	الصفه	المؤهلالعلمي	البريد الالكتروني	رقم الهاتف
1	د/ فرج مصباح المبروك	كلية الهندسة / جامعة بنغازي	عضو هيئة تدريس	دكتوراه	faraj.elmabrouk@uob.edu.ly	0923136685
2	أ- عماد سالم الجحدوي	[illegible] للبناء والتشييد	رئيس قسم العمارة	ماجستير عمارة	almldi@Yahoo.com	0926355468
3	م. محمود صالح محمود العبيدي	مكتب العمارة	مدير مشروع الجيل الثالث	ب. عمارة	Mahmoud@yahoo.com	0925301225
4	م- عبدالحفيظ [illegible]	شركة الكرامات العالمية	الفني	بكالوريوس [illegible]	HAfiD@gmail.	0925102688
5	م. صالح بوحمور	شركة الخدمات	رئيس مكتب الإزالة	[illegible]	SALAH.MM.48	092564760
6	م. وليد محمد الهلالي	الهيئة العامة للبيئة	مدير فرع بنغازي	ماجستير	hilali123@gmail.com	0925164774
7	أ. سعيد عوض عبدالله سعيد	المعهد العالي [illegible]	عضو هيئة تدريس	ماجستير	Emadowd@Yahoo.com	0924138370
8	[illegible] الخشف	المعهد العالي [illegible]	مدير إدارة الموارد البشرية	[illegible]		0925480304
9	م. محمود احمد سالم	ديوان [illegible]	مهندس	[illegible]		0925814432
10	أ.م/ عياد عبد العجيلي	الصندوق الوطني [illegible]	رئيس قسم [illegible]	ماجستير	Ayad.Elagilli@Gmail.	0925105831
11	عبدالباسط محمد [illegible]	[illegible] مؤسسة [illegible]	رئيس [illegible]	ماجستير	Bait80@yahoo.com	09261784253
12						
13						
14						
15						

Appendix 4: Ethical Approval

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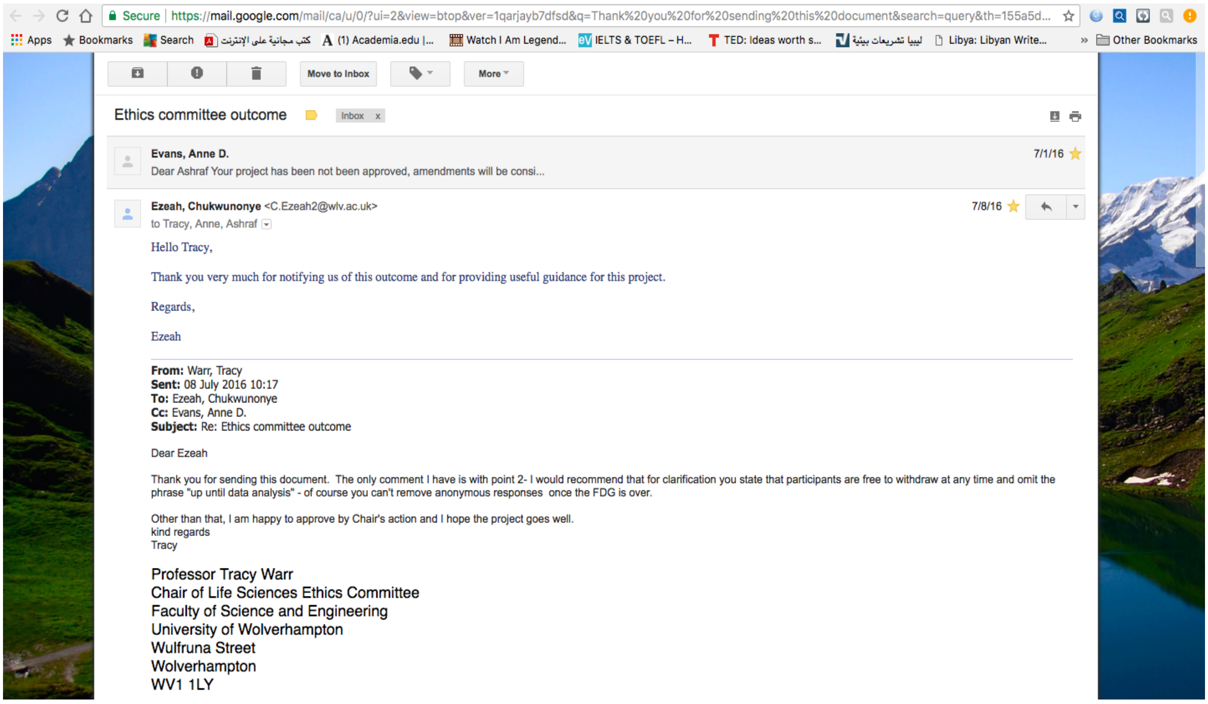

Ethics committee outcome Inbox x

Evans, Anne D. 7/1/16
Dear Ashraf Your project has been not been approved, amendments will be consi...

Ezeah, Chukwunonye <C.Ezeah2@wlv.ac.uk> 7/8/16
to Tracy, Anne, Ashraf

Hello Tracy,

Thank you very much for notifying us of this outcome and for providing useful guidance for this project.

Regards,

Ezeah

From: Warr, Tracy
Sent: 08 July 2016 10:17
To: Ezeah, Chukwunonye
Cc: Evans, Anne D.
Subject: Re: Ethics committee outcome

Dear Ezeah

Thank you for sending this document. The only comment I have is with point 2- I would recommend that for clarification you state that participants are free to withdraw at any time and omit the phrase "up until data analysis" - of course you can't remove anonymous responses once the FDG is over.

Other than that, I am happy to approve by Chair's action and I hope the project goes well.
kind regards
Tracy

Professor Tracy Warr
Chair of Life Sciences Ethics Committee
Faculty of Science and Engineering
University of Wolverhampton
Wulfruna Street
Wolverhampton
WV1 1LY

Appendix 5: Consent Form (Framework Evaluation)

Consent Form (Participant in a Framework Evaluation)

Title of study: **Development framework for sustainable construction waste management in the Libyan context**

Lead researcher: **Ashraf Ali**
Ph.D. student University of Wolverhampton, UK,
School of Architecture and Built Environment and Built Environmental
Tel: 00441902322671
Email:A.Ali43@wlv.ac.uk
Assear2008@gmail.com

Supervision: **Dr. David Oloke, Prof Craig Williamas, Dr. Ezeah and Prof Jamal Khatib**
Email:D.A.Oloke@wlv.ac.uk

Dear Sir/Madam

Thank you for your active participation in the above titled research till date. I am writing to invite you to kind participate again **in a framework evaluation** (as part of my PhD research project, at the School of Architecture and Built Environment, Faculty of Science and Engineering, University of Wolverhampton, UK. I am undertaking the **framework evaluation** to evaluate proposed framework were particularly interests in the opinion of Libyan experts. This is in order to ensure the main goal can be achieved. As the main research aim is to develop a framework for sustainable construction waste management in Libyan. You have been identified as an expert in one of the areas of interest that my research is covering from your work with relevant organisations. Please be assured that anything you say in the course of the discussion would be held in utmost confidentiality. All personal data will be anonymised to protect the identity of participants and any notes taken during the interview would be destroyed afterwards. We will appreciate receiving your consent for participation via email (A.Ali43@wlv.ac.uk). Thanking you in advance for your kind consideration.

Yours sincerely

Ashraf Ali

Appendix 6: Framework Evaluation Questionnaire

Framework Evaluation Questionnaire

Development of Framework for sustainable construction waste management in the Libyan context

In connection to the rationale and usefulness of the proposed framework for SC&DWM in Libya, a number of questions have been asked below. Kindly provide us with your view on the proposed framework by completing questions.

Q1. Are the key elements and stages of the framework appropriate enough to obtain SC&DWM practices in Libya?

☐ Strongly disagree	☐ Disagree	☐ Neutral	☐ Agree	☐ Strongly agree	☐ Not sure

Please clarify why chose this answer

Q2. Does the framework cover all the steps needed to achieve SC&DWM practices?

☐ Strongly disagree	☐ Disagree	☐ Neutral	☐ Agree	☐ Strongly agree	☐ Not sure

Please clarify why chose this answer

Q3. How relevant did you find this framework to the Libyan context?

☐ No comments	☐ Not relevant	☐ Relevant	☐ Very relevant

Please clarify why chose this answer

Q4. How logical did you find this framework?

☐ No comments	☐ Not logical	☐ Logical	☐ Very logical

Please clarify why chose this answer

Q5. Would you say the framework is clear and easy to understand?

☐ Yes	☐ No	☐ Not sure

Please clarify why chose this answer

Q6. What is your view on the description of the framework and its layout?

☐ It is comprehensive	☐ It is adequate	☐ It is poor	☐ Not sure

Please clarify why chose this answer

Q7. Would you say the framework is a workable?

☐ Yes	☐ No	☐ Not sure

Please clarify why chose this answer

Q8. This framework implementation guide, if followed; will facilitate the sustainable management of C&D waste by government and related organisations.

Please rate your agreement with the above statement.

☐ Strongly disagree	☐ Disagree	☐ Neutral	☐ Agree	☐ Strongly agree	☐ Not sure

Please clarify why chose this answer

Q9. In your view, are there any further matters of importance or recommendations which should to be included and/or considered in the framework?

☐ Yes	☐ No	☐ Not sure

Please clarify why chose this answer

Appendix 7: Summarised SPSS Descriptive Statistical Analysis

Respondents Group	Barriers											
	1- waste policies lack clear strategies for action			2-Laws regulating waste management are inadequate (lack of government interventions)			3-Construction waste management institutions are weak			4-Unplanned aspects of the city make construction waste collection difficult		
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Public	3.79	1.557	970	3.73	1.563	970	3.91	1.509	970	4.03	1.339	970
Expert group	4.05	1.445	111	4.02	1.342	111	4.10	1.355	111	3.94	1.309	111
Policy maker	4.84	.554	25	4.36	1.319	25	4.32	1.314	25	4.60	.913	25
GPiE&WM	3.68	1.451	34	4.15	1.184	34	4.12	1.122	34	3.85	1.282	34
Total	3.83	1.537	1140	3.79	1.532	1140	3.95	1.481	1140	4.03	1.329	1140
Respondents Group	5-Availability of dumping grounds discourages expensive investment in alternative disposal methods			6-Limited funds available are sometimes misused			7-Public education on construction waste management is low			8- Waste workers are poorly trained and poorly paid		
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Public	3.86	1.428	970	4.08	1.416	970	4.03	1.475	970	4.15	1.372	970
Expert group	3.93	1.469	111	4.17	1.292	111	4.31	1.085	111	4.18	1.302	111
Policy maker	4.08	.997	25	4.68	1.030	25	4.64	.810	25	4.80	.866	25
GPiE&WM	3.85	1.132	34	4.41	1.048	34	4.41	.821	34	3.97	1.218	34
Total	3.86	1.428	970	4.11	1.390	1140	4.08	1.420	1140	4.16	1.355	1140
Respondents Group	9-Operational equipment is obsolete and insufficient			10-There is no tax to control construction waste disposal			11-Types of material e.g. produce unrecyclable materials			12-Encouragement (e.g. financial incentives)		
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Public	4.05	1.445	970	4.14	1.439	970	3.82	1.717	970	4.07	1.478	970
Expert group	4.18	1.295	111	4.38	1.145	111	3.47	1.650	111	4.08	1.308	111
Policy maker	5.00	.289	25	4.96	.539	25	3.64	1.350	25	5.00	.289	25
GPiE&WM	4.09	1.334	34	4.29	1.268	34	3.65	1.773	34	3.56	1.599	34
Total	4.08	1.418	1140	4.19	1.400	1140	3.78	1.707	1140	4.08	1.458	1140

Respondents Group	13-Different waste management service from one place to another e.g. city, town, village etc.			14-Lack in the facilities of waste management			15-The lack of reliable data base (quantity of C&D waste recycling reusing recovering and disposal)			16-No review of waste management plans on a regular basis		
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Public	3.75	1.650	970	4.22	1.436	970	4.07	1.485	970	4.04	1.488	970
Expert group	3.78	1.449	111	4.40	1.267	111	4.14	1.304	111	4.07	1.353	111
Policy maker	5.44	.583	25	5.00	.408	25	5.00	.408	25	5.04	.351	25
GPiE&WM	3.82	1.290	34	4.44	.991	34	3.97	1.087	34	3.71	1.338	34
Total	3.79	1.623	1140	4.26	1.399	1140	4.09	1.448	1140	4.05	1.463	1140

Respondents Group	17-Lack of interest from clients			18-Lack of market competition			19-Attitude of some construction professional such as architects and engineers		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Public	4.07	1.399	970	4.02	1.502	970	3.91	1.525	970
Expert group	4.04	1.361	111	4.28	1.376	111	3.83	1.407	111
Policy maker	5.00	.289	25	4.88	.726	25	4.00	1.118	25
GPiE&WM	4.00	1.206	34	3.76	1.103	34	3.68	1.093	34
Total	4.09	1.381	1140	4.06	1.474	1140	3.90	1.494	1140

Legend

Total average

Highest mean

Lowest mean

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Appendix 8: Tests of Between-Subjects Effects (Analysis of Variance of Barriers)

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Waste policies lack clear strategies for action	33.788[a]	3	11.263	4.817	.002
	Laws regulating waste management are inadequate (lack of government interventions)	21.586[b]	3	7.195	3.081	.027
	Construction waste management institutions are weak	8.065[c]	3	2.688	1.226	.299
	Unplanned aspects of the city make construction waste collection difficult	10.153[d]	3	3.384	1.922	.124
	Availability of dumping grounds discourages expensive investment in alternative disposal methods	1.630[e]	3	.543	.271	.847
	Limited funds available are sometimes misused	12.605[f]	3	4.202	2.180	.089
	Public education on construction waste management is low	20.115[g]	3	6.705	3.347	.019
	Waste workers are poorly trained and poorly paid	11.610[h]	3	3.870	2.115	.097
	Operational equipment are obsolete and insufficient	23.440[i]	3	7.813	3.915	.009
	There is no tax for control construction waste disposal	21.153[j]	3	7.051	3.625	.013
	Types of the material e.g. (produce unrecyclable materials)	13.629[k]	3	4.543	1.562	.197
	Encouragement e.g. financial incentives	30.451[l]	3	10.150	4.821	.002
	Different waste management service from one place to another e.g. City, town, village etc	70.036[m]	3	23.345	9.045	.000
	Lack in the facilities of waste management	18.619[n]	3	6.206	3.190	.023
	The lack of reliable data base (quantity of construction and demolition waste recycling reusing recovering and disposal)	21.828[o]	3	7.276	3.493	.015
	No review of waste management plans on a regular basis	28.799[p]	3	9.600	4.528	.004
	Lack of interest from clients	21.569[q]	3	7.190	3.799	.010
	Lack of market competition	26.318[r]	3	8.773	4.070	.007
	Attitude of some construction professional such as architects and Engineers	2.685[s]	3	.895	.400	.753
Intercept	Waste policies lack clear strategies for action	3367.099	1	3367.099	1440.213	.000
	Laws regulating waste management are inadequate (lack of government interventions)	3326.017	1	3326.017	1424.310	.000
	Construction waste management institutions are weak	3406.362	1	3406.362	1553.582	.000
	Unplanned aspects of the city make construction waste collection difficult	3394.222	1	3394.222	1927.116	.000
	Availability of dumping grounds discourages expensive investment in alternative disposal methods	3109.744	1	3109.744	1549.487	.000
	Limited funds available are sometimes misused	3784.944	1	3784.944	1963.808	.000
	Public education on construction waste management is low	3803.544	1	3803.544	1898.483	.000
	Waste workers are poorly trained and poorly paid	3680.458	1	3680.458	2011.361	.000
	Operational equipment are obsolete and insufficient	3772.944	1	3772.944	1890.520	.000
	There is no tax for control construction waste disposal	3977.455	1	3977.455	2044.593	.000
	Types of the material e.g. (produce unrecyclable materials)	2674.885	1	2674.885	919.509	.000
	Encouragement e.g. financial incentives	3515.258	1	3515.258	1669.732	.000
	Different waste management service from one place to another e.g. City, town, village etc	3549.249	1	3549.249	1375.145	.000
	Lack in the facilities of waste management	4102.953	1	4102.953	2108.988	.000

	The lack of reliable data base (quantity of construction and demolition waste recycling reusing recovering and disposal)	3712.615	1	3712.615	1782.320	.000
	No review of waste management plans on a regular basis	3574.798	1	3574.798	1686.274	.000
	Lack of interest from clients	3684.324	1	3684.324	1947.003	.000
	Lack of market competition	3615.522	1	3615.522	1677.444	.000
	Attitude of some construction professional such as architects and Engineers	2992.212	1	2992.212	1338.294	.000
Participant	Waste policies lack clear strategies for action	33.788	3	11.263	4.817	.002
	Laws regulating waste management are inadequate (lack of government interventions)	21.586	3	7.195	3.081	.027
	Construction waste management institutions are weak	8.065	3	2.688	1.226	.299
	Unplanned aspects of the city make construction waste collection difficult	10.153	3	3.384	1.922	.124
	Availability of dumping grounds discourages expensive investment in alternative disposal methods	1.630	3	.543	.271	.847
	Limited funds available are sometimes misused	12.605	3	4.202	2.180	.089
	Public education on construction waste management is low	20.115	3	6.705	3.347	.019
	Waste workers are poorly trained and poorly paid	11.610	3	3.870	2.115	.097
	Operational equipment are obsolete and insufficient	23.440	3	7.813	3.915	.009
	There is no tax for control construction waste disposal	21.153	3	7.051	3.625	.013
	Types of the material e.g. (produce unrecyclable materials)	13.629	3	4.543	1.562	.197
	Encouragement e.g. financial incentives	30.451	3	10.150	4.821	.002
	Different waste management service from one place to another e.g. City, town, village etc	70.036	3	23.345	9.045	.000
	Lack in the facilities of waste management	18.619	3	6.206	3.190	.023
	The lack of reliable data base (quantity of construction and demolition waste recycling reusing recovering and disposal)	21.828	3	7.276	3.493	.015
	No review of waste management plans on a regular basis	28.799	3	9.600	4.528	.004
	Lack of interest from clients	21.569	3	7.190	3.799	.010
	Lack of market competition	26.318	3	8.773	4.070	.007
	Attitude of some construction professional such as architects and Engineers	2.685	3	.895	.400	.753
Error	Waste policies lack clear strategies for action	2655.875	1136	2.338		
	Laws regulating waste management are inadequate (lack of government interventions)	2652.761	1136	2.335		
	Construction waste management institutions are weak	2490.777	1136	2.193		
	Unplanned aspects of the city make construction waste collection difficult	2000.833	1136	1.761		
	Availability of dumping grounds discourages expensive investment in alternative disposal methods	2279.895	1136	2.007		
	Limited funds available are sometimes misused	2189.468	1136	1.927		
	Public education on construction waste management is low	2275.937	1136	2.003		
	Waste workers are poorly trained and poorly paid	2078.692	1136	1.830		
	Operational equipment are obsolete and insufficient	2267.136	1136	1.996		
	There is no tax for control construction waste disposal	2209.921	1136	1.945		
	Types of the material e.g. (produce unrecyclable materials)	3304.665	1136	2.909		

	Encouragement e.g. financial incentives	2391.601	1136	2.105		
	Different waste management service from one place to another e.g. City, town, village etc	2932.016	1136	2.581		
	Lack in the facilities of waste management	2210.043	1136	1.945		
	The lack of reliable data base (quantity of construction and demolition waste recycling reusing recovering and disposal)	2366.316	1136	2.083		
	No review of waste management plans on a regular basis	2408.250	1136	2.120		
	Lack of interest from clients	2149.659	1136	1.892		
	Lack of market competition	2448.506	1136	2.155		
	Attitude of some construction professional such as architects and Engineers	2539.915	1136	2.236		
Total	Waste policies lack clear strategies for action	19426.000	1140			
	Laws regulating waste management are inadequate (lack of government interventions)	19007.000	1140			
	Construction waste management institutions are weak	20262.000	1140			
	Unplanned aspects of the city make construction waste collection difficult	20524.000	1140			
	Availability of dumping grounds discourages expensive investment in alternative disposal methods	19349.000	1140			
	Limited funds available are sometimes misused	21464.000	1140			
	Public education on construction waste management is low	21255.000	1140			
	Waste workers are poorly trained and poorly paid	21832.000	1140			
	Operational equipment are obsolete and insufficient	21274.000	1140			
	There is no tax for control construction waste disposal	22240.000	1140			
	Types of the material e.g. (produce unrecyclable materials)	19598.000	1140			
	Encouragement e.g. financial incentives	21381.000	1140			
	Waste management service from one place to another e.g. City, town, village etc	19365.000	1140			
	Lack in the facilities of waste management	22905.000	1140			
	lack of reliable data base (quantity of construction and demolition waste recycling reusing recovering and disposal)	21486.000	1140			
	No review of waste management plans on a regular basis	21144.000	1140			
	Lack of interest from clients	21220.000	1140			
	Lack of market competition	21271.000	1140			
	of some construction professional such as architects and Engineers	19882.000	1140			
Corrected Total	Waste policies lack clear strategies for action	2689.663	1139			
	Laws regulating waste management are inadequate (lack of government interventions)	2674.346	1139			

	Construction waste management institutions are weak	2498.842	1139			
	Unplanned aspects of the city make construction waste collection difficult	2010.986	1139			
	Availability of dumping grounds discourages expensive investment in alternative disposal methods	2281.525	1139			
	Limited funds available are sometimes misused	2202.074	1139			
	Public education on construction waste management is low	2296.052	1139			
	Waste workers are poorly trained and poorly paid	2090.302	1139			
	Operational equipment are obsolete and insufficient	2290.575	1139			
	There is no tax for control construction waste disposal	2231.074	1139			
	Types of the material e.g. (produce unrecyclable materials)	3318.295	1139			
	Encouragement e.g. financial incentives	2422.052	1139			
	Different waste management service from one place to another e.g. City, town, village etc	3002.052	1139			
	Lack in the facilities of waste management	2228.662	1139			
	The lack of reliable data base (quantity of construction and demolition waste recycling reusing recovering and disposal)	2388.144	1139			
	No review of waste management plans on a regular basis	2437.049	1139			
	Lack of interest from clients	2171.228	1139			
	Lack of market competition	2474.824	1139			
	Attitude of some construction professional such as architects and Engineers	2542.600	1139			

Appendix 9: Model Estimated Marginal Means and Standard Errors

Dependent Variable	Participants	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Waste policies lack clear strategies for action	Public	3.786	.049	3.689	3.882
	Expert Group	4.054	.145	3.769	4.339
	Policy Maker	4.840	.306	4.240	5.440
	GPiE&WM.	3.676	.262	3.162	4.191
Laws regulating waste management are inadequate (lack of government interventions)	Public	3.731	.049	3.635	3.827
	Expert Group	4.018	.145	3.733	4.303
	Policy Maker	4.360	.306	3.760	4.960
	GPiE&WM.	4.147	.262	3.633	4.661
Construction waste management institutions are weak	Public	3.914	.048	3.821	4.008
	Expert Group	4.099	.141	3.823	4.375
	Policy Maker	4.320	.296	3.739	4.901
	GPiE&WM.	4.118	.254	3.619	4.616
Unplanned aspects of the city make construction waste collection difficult	Public	4.032	.043	3.948	4.116
	Expert Group	3.937	.126	3.690	4.184
	Policy Maker	4.600	.265	4.079	5.121
	GPiE&WM.	3.853	.228	3.406	4.300
Availability of dumping grounds discourages expensive investment in alternative disposal methods	Public	3.858	.045	3.768	3.947
	Expert Group	3.928	.134	3.664	4.192
	Policy Maker	4.080	.283	3.524	4.636
	GPiE&WM.	3.853	.243	3.376	4.330
Limited funds available are sometimes misused	Public	4.078	.045	3.991	4.166
	Expert Group	4.171	.132	3.913	4.430
	Policy Maker	4.680	.278	4.135	5.225
	GPiE&WM.	4.412	.238	3.945	4.879
Public education on construction waste management is low	Public	4.026	.045	3.937	4.115
	Expert Group	4.306	.134	4.043	4.570
	Policy Maker	4.640	.283	4.085	5.195
	GPiE&WM.	4.412	.243	3.935	4.888
Waste workers are poorly trained and poorly paid	Public	4.149	.043	4.064	4.235
	Expert Group	4.180	.128	3.928	4.432
	Policy Maker	4.800	.271	4.269	5.331
	GPiE&WM.	3.971	.232	3.515	4.426
Operational equipment are obsolete and insufficient	Public	4.045	.045	3.956	4.134
	Expert Group	4.180	.134	3.917	4.443
	Policy Maker	5.000	.283	4.446	5.554
	GPiE&WM.	4.088	.242	3.613	4.564

There is no tax for control construction waste disposal	Public	4.144	.045	4.056	4.232
	Expert Group	4.378	.132	4.119	4.638
	Policy Maker	4.960	.279	4.413	5.507
	GPiE&WM.	4.294	.239	3.825	4.763
Types of the material e.g. (produce unrecyclable materials)	Public	3.823	.055	3.715	3.930
	Expert Group	3.468	.162	3.151	3.786
	Policy Maker	3.640	.341	2.971	4.309
	GPiE&WM.	3.647	.293	3.073	4.221
Encouragement e.g. financial incentives	Public	4.072	.047	3.981	4.164
	Expert Group	4.081	.138	3.811	4.351
	Policy Maker	5.000	.290	4.431	5.569
	GPiE&WM.	3.559	.249	3.071	4.047
Different waste management service from one place to another e.g. City, town, village etc	Public	3.745	.052	3.644	3.847
	Expert Group	3.784	.152	3.485	4.083
	Policy Maker	5.440	.321	4.810	6.070
	GPiE&WM.	3.824	.276	3.283	4.364
Lack in the facilities of waste management	Public	4.218	.045	4.130	4.305
	Expert Group	4.396	.132	4.137	4.656
	Policy Maker	5.000	.279	4.453	5.547
	GPiE&WM.	4.441	.239	3.972	4.911
The lack of reliable data base (quantity of construction and demolition waste recycling reusing recovering and disposal)	Public	4.069	.046	3.978	4.160
	Expert Group	4.135	.137	3.866	4.404
	Policy Maker	5.000	.289	4.434	5.566
	GPiE&WM.	3.971	.248	3.485	4.456
No review of waste management plans on a regular basis	Public	4.035	.047	3.943	4.127
	Expert Group	4.072	.138	3.801	4.343
	Policy Maker	5.040	.291	4.469	5.611
	GPiE&WM.	3.706	.250	3.216	4.196
Lack of interest from clients	Public	4.073	.044	3.987	4.160
	Expert Group	4.036	.131	3.780	4.292
	Policy Maker	5.000	.275	4.460	5.540
	GPiE&WM.	4.000	.236	3.537	4.463
Lack of market competition	Public	4.025	.047	3.932	4.117
	Expert Group	4.279	.139	4.006	4.553
	Policy Maker	4.880	.294	4.304	5.456
	GPiE&WM.	3.765	.252	3.271	4.259
Attitude of some construction professional such as architects and Engineers	Public	3.913	.048	3.819	4.008
	Expert Group	3.829	.142	3.550	4.107
	Policy Maker	4.000	.299	3.413	4.587
	GPiE&WM.	3.676	.256	3.173	4.180

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Appendix 10: Post-Hoc Tests (Multiple Comparisons of Variance Barriers)

Dependent Variable	(I) Respondents	(J) Respondents	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
1- Waste policies lack clear strategies for action	Public	Expert group	-.27-	.153	.381	-.70-	.16
		Policy maker	-1.05-*	.310	.009	-1.92-	-.19-
		GPiE&WM	.11	.267	.983	-.64-	.86
	Expert group	Public	.27	.153	.381	-.16-	.70
		Policy maker	-.79-	.338	.146	-1.73-	.16
		GPiE&WM	.38	.300	.662	-.46-	1.22
	Policy maker	Public	1.05*	.310	.009	.19	1.92
		Expert group	.79	.338	.146	-.16-	1.73
		GPiE&WM	1.16*	.403	.040	.04	2.29
	GPiE&WM	Public	-.11-	.267	.983	-.86-	.64
		Expert group	-.38-	.300	.662	-1.22-	.46
		Policy maker	-1.16-*	.403	.040	-2.29-	-.04-
2-Laws regulating waste management are inadequate (lack of government interventions)	Public	Expert group	-.29-	.153	.319	-.72-	.14
		Policy maker	-.63-	.310	.248	-1.50-	.24
		GPiE&WM	-.42-	.267	.487	-1.16-	.33
	Expert group	Public	.29	.153	.319	-.14-	.72
		Policy maker	-.34-	.338	.796	-1.29-	.61
		GPiE&WM	-.13-	.300	.980	-.97-	.71
	Policy maker	Public	.63	.310	.248	-.24-	1.50
		Expert group	.34	.338	.796	-.61-	1.29
		GPiE&WM	.21	.403	.964	-.91-	1.34
	GPiE&WM	Public	.42	.267	.487	-.33-	1.16
		Expert group	.13	.300	.980	-.71-	.97
		Policy maker	-.21-	.403	.964	-1.34-	.91
3-Construction waste management institutions are weak	Public	Expert group	-.18-	.148	.671	-.60-	.23
		Policy maker	-.41-	.300	.609	-1.25-	.43
		GPiE&WM	-.20-	.258	.892	-.93-	.52
	Expert group	Public	.18	.148	.671	-.23-	.60
		Policy maker	-.22-	.328	.929	-1.14-	.70
		GPiE&WM	-.02-	.290	1.000	-.83-	.79
	Policy maker	Public	.41	.300	.609	-.43-	1.25
		Expert group	.22	.328	.929	-.70-	1.14
		GPiE&WM	.20	.390	.966	-.89-	1.29
	GPiE&WM	Public	.20	.258	.892	-.52-	.93
		Expert group	.02	.290	1.000	-.79-	.83

		Policy maker	-.20-	.390	.966	-1.29-	.89
4-Unplanned aspects of the city make construction waste collection difficult	Public	Expert group	.10	.133	.917	-.28-	.47
		Policy maker	-.57-	.269	.216	-1.32-	.18
		GPiE&WM	.18	.232	.897	-.47-	.83
	Expert group	Public	-.10-	.133	.917	-.47-	.28
		Policy maker	-.66-	.294	.166	-1.49-	.16
		GPiE&WM	.08	.260	.991	-.64-	.81
	Policy maker	Public	.57	.269	.216	-.18-	1.32
		Expert group	.66	.294	.166	-.16-	1.49
		GPiE&WM	.75	.350	.207	-.23-	1.73
	GPiE&WM	Public	-.18-	.232	.897	-.83-	.47
		Expert group	-.08-	.260	.991	-.81-	.64
		Policy maker	-.75-	.350	.207	-1.73-	.23
5-Availability of dumping grounds discourages expensive investment in alternative disposal methods	Public	Expert group	-.07-	.142	.970	-.47-	.33
		Policy maker	-.22-	.287	.896	-1.03-	.58
		GPiE&WM	.00	.247	1.000	-.69-	.70
	Expert group	Public	.07	.142	.970	-.33-	.47
		Policy maker	-.15-	.314	.972	-1.03-	.73
		GPiE&WM	.07	.278	.995	-.70-	.85
	Policy maker	Public	.22	.287	.896	-.58-	1.03
		Expert group	.15	.314	.972	-.73-	1.03
		GPiE&WM	.23	.373	.946	-.82-	1.27
	GPiE&WM	Public	.00	.247	1.000	-.70-	.69
		Expert group	-.07-	.278	.995	-.85-	.70
		Policy maker	-.23-	.373	.946	-1.27-	.82
6-Limited funds available are sometimes misused	Public	Expert group	-.09-	.139	.931	-.48-	.30
		Policy maker	-.60-	.281	.206	-1.39-	.19
		GPiE&WM	-.33-	.242	.595	-1.01-	.34
	Expert group	Public	.09	.139	.931	-.30-	.48
		Policy maker	-.51-	.307	.434	-1.37-	.35
		GPiE&WM	-.24-	.272	.854	-1.00-	.52
	Policy maker	Public	.60	.281	.206	-.19-	1.39
		Expert group	.51	.307	.434	-.35-	1.37
		GPiE&WM	.27	.366	.910	-.76-	1.29
	GPiE&WM	Public	.33	.242	.595	-.34-	1.01
		Expert group	.24	.272	.854	-.52-	1.00
		Policy maker	-.27-	.366	.910	-1.29-	.76
7-Public education on construction waste management is low	Public	Expert group	-.28-	.142	.272	-.68-	.12
		Policy maker	-.61-	.287	.205	-1.42-	.19
		GPiE&WM	-.39-	.247	.486	-1.08-	.31
	Expert group	Public	.28	.142	.272	-.12-	.68
		Policy maker	-.33-	.313	.769	-1.21-	.54

		GPiE&WM	-.11-	.277	.986	-.88-	.67
	Policy maker	Public	.61	.287	.205	-.19-	1.42
		Expert group	.33	.313	.769	-.54-	1.21
		GPiE&WM	.23	.373	.945	-.82-	1.27
	GPiE&WM	Public	.39	.247	.486	-.31-	1.08
		Expert group	.11	.277	.986	-.67-	.88
		Policy maker	-.23-	.373	.945	-1.27-	.82
8- Waste workers are poorly trained and poorly paid	Public	Expert group	-.03-	.136	.997	-.41-	.35
		Policy maker	-.65-	.274	.131	-1.42-	.12
		GPiE&WM	.18	.236	.902	-.48-	.84
	Expert group	Public	.03	.136	.997	-.35-	.41
		Policy maker	-.62-	.299	.233	-1.46-	.22
		GPiE&WM	.21	.265	.891	-.53-	.95
	Policy maker	Public	.65	.274	.131	-.12-	1.42
		Expert group	.62	.299	.233	-.22-	1.46
		GPiE&WM	.83	.356	.144	-.17-	1.83
	GPiE&WM	Public	-.18-	.236	.902	-.84-	.48
		Expert group	-.21-	.265	.891	-.95-	.53
		Policy maker	-.83-	.356	.144	-1.83-	.17
9-Operational equipment is obsolete and insufficient	Public	Expert group	-.13-	.142	.824	-.53-	.26
		Policy maker	-.95-*	.286	.011	-1.76-	-.15-
		GPiE&WM	-.04-	.246	.999	-.73-	.65
	Expert group	Public	.13	.142	.824	-.26-	.53
		Policy maker	-.82-	.313	.077	-1.70-	.06
		GPiE&WM	.09	.277	.991	-.68-	.87
	Policy maker	Public	.95*	.286	.011	.15	1.76
		Expert group	.82	.313	.077	-.06-	1.70
		GPiE&WM	.91	.372	.112	-.13-	1.95
	GPiE&WM	Public	.04	.246	.999	-.65-	.73
		Expert group	-.09-	.277	.991	-.87-	.68
		Policy maker	-.91-	.372	.112	-1.95-	.13
10-There is no tax to control construction waste disposal	Public	Expert group	-.23-	.140	.423	-.63-	.16
		Policy maker	-.82-*	.283	.040	-1.61-	-.02-
		GPiE&WM	-.15-	.243	.945	-.83-	.53
	Expert group	Public	.23	.140	.423	-.16-	.63
		Policy maker	-.58-	.309	.315	-1.45-	.28
		GPiE&WM	.08	.273	.992	-.68-	.85
	Policy maker	Public	.82*	.283	.040	.02	1.61
		Expert group	.58	.309	.315	-.28-	1.45
		GPiE&WM	.67	.367	.350	-.36-	1.69
	GPiE&WM	Public	.15	.243	.945	-.53-	.83
		Expert group	-.08-	.273	.992	-.85-	.68

		Policy maker	-.67-	.367	.350	-1.69-	.36
11-Types of material (e.g. produce unrecyclable materials)	Public	Expert group	.35	.171	.232	-.12-	.83
		Policy maker	.18	.345	.964	-.78-	1.15
		GPiE&WM	.18	.298	.951	-.66-	1.01
	Expert group	Public	-.35-	.171	.232	-.83-	.12
		Policy maker	-.17-	.378	.977	-1.23-	.89
		GPiE&WM	-.18-	.334	.963	-1.11-	.76
	Policy maker	Public	-.18-	.345	.964	-1.15-	.78
		Expert group	.17	.378	.977	-.89-	1.23
		GPiE&WM	-.01-	.449	1.000	-1.27-	1.25
	GPiE&WM	Public	-.18-	.298	.951	-1.01-	.66
		Expert group	.18	.334	.963	-.76-	1.11
		Policy maker	.01	.449	1.000	-1.25-	1.27
12-Encouragement (e.g. financial incentives)	Public	Expert group	-.01-	.145	1.000	-.42-	.40
		Policy maker	-.93-*	.294	.019	-1.75-	-.10-
		GPiE&WM	.51	.253	.250	-.20-	1.22
	Expert group	Public	.01	.145	1.000	-.40-	.42
		Policy maker	-.92-*	.321	.043	-1.82-	-.02-
		GPiE&WM	.52	.284	.338	-.27-	1.32
	Policy maker	Public	.93*	.294	.019	.10	1.75
		Expert group	.92*	.321	.043	.02	1.82
		GPiE&WM	1.44*	.382	.003	.37	2.51
	GPiE&WM	Public	-.51-	.253	.250	-1.22-	.20
		Expert group	-.52-	.284	.338	-1.32-	.27
		Policy maker	-1.44-*	.382	.003	-2.51-	-.37-
13-Different waste management service from one place to another (e.g. city, town, village etc.)	Public	Expert group	-.04-	.161	.996	-.49-	.41
		Policy maker	-1.69-*	.325	.000	-2.61-	-.78-
		GPiE&WM	-.08-	.280	.994	-.86-	.71
	Expert group	Public	.04	.161	.996	-.41-	.49
		Policy maker	-1.66-*	.356	.000	-2.65-	-.66-
		GPiE&WM	-.04-	.315	.999	-.92-	.84
	Policy maker	Public	1.69*	.325	.000	.78	2.61
		Expert group	1.66*	.356	.000	.66	2.65
		GPiE&WM	1.62*	.423	.002	.43	2.80
	GPiE&WM	Public	.08	.280	.994	-.71-	.86
		Expert group	.04	.315	.999	-.84-	.92
		Policy maker	-1.62-*	.423	.002	-2.80-	-.43-
14-Lack in the facilities of waste management	Public	Expert group	-.18-	.140	.651	-.57-	.21
		Policy maker	-.78-	.283	.054	-1.57-	.01
		GPiE&WM	-.22-	.243	.839	-.90-	.46
	Expert group	Public	.18	.140	.651	-.21-	.57
		Policy maker	-.60-	.309	.282	-1.47-	.26

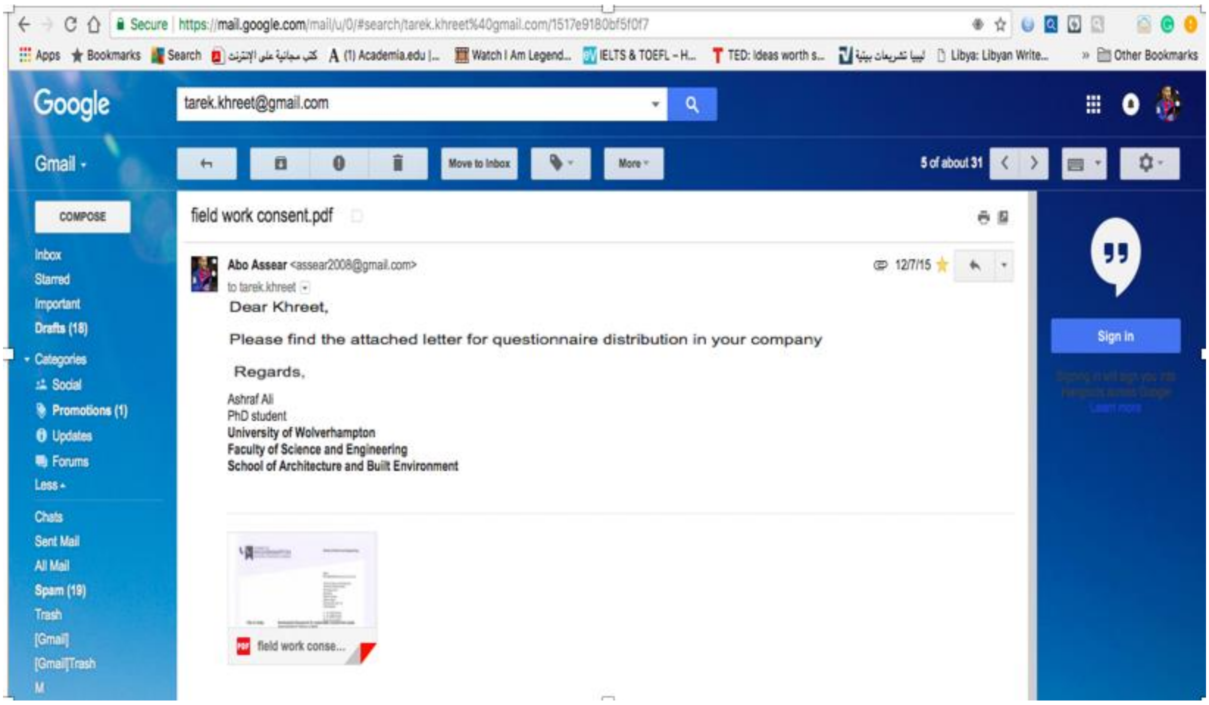
		GPiE&WM	-.04-	.273	.999	-.81-	.72
	Policy maker	Public	.78	.283	.054	-.01-	1.57
		Expert group	.60	.309	.282	-.26-	1.47
		GPiE&WM	.56	.367	.510	-.47-	1.59
	GPiE&WM	Public	.22	.243	.839	-.46-	.90
		Expert group	.04	.273	.999	-.72-	.81
		Policy maker	-.56-	.367	.510	-1.59-	.47
15-The lack of reliable data base (quantity of construction and demolition waste recycling reusing recovering and disposal)	Public	Expert group	-.07-	.145	.976	-.47-	.34
		Policy maker	-.93-*	.292	.018	-1.75-	-.11-
		GPiE&WM	.10	.252	.985	-.61-	.80
	Expert group	Public	.07	.145	.976	-.34-	.47
		Policy maker	-.86-	.320	.063	-1.76-	.03
		GPiE&WM	.16	.283	.953	-.63-	.96
	Policy maker	Public	.93*	.292	.018	.11	1.75
		Expert group	.86	.320	.063	-.03-	1.76
		GPiE&WM	1.03	.380	.063	-.04-	2.09
	GPiE&WM	Public	-.10-	.252	.985	-.80-	.61
16-No review of waste management plans on a regular basis	Public	Expert group	-.16-	.283	.953	-.96-	.63
		Policy maker	-1.03-	.380	.063	-2.09-	.04
		Policy maker	-1.00-*	.295	.009	-1.83-	-.18-
		GPiE&WM	.33	.254	.642	-.38-	1.04
	Expert group	Public	.04	.146	.996	-.37-	.45
		Policy maker	-.97-*	.322	.029	-1.87-	-.07-
		GPiE&WM	.37	.285	.649	-.43-	1.17
	Policy maker	Public	1.00*	.295	.009	.18	1.83
		Expert group	.97*	.322	.029	.07	1.87
		GPiE&WM	1.33*	.384	.007	.26	2.41
	GPiE&WM	Public	-.33-	.254	.642	-1.04-	.38
		Expert group	-.37-	.285	.649	-1.17-	.43
		Policy maker	-1.33-*	.384	.007	-2.41-	-.26-
17-Lack of interest from clients	Public	Expert group	.04	.138	.995	-.35-	.42
		Policy maker	-.93-*	.279	.012	-1.71-	-.15-
		GPiE&WM	.07	.240	.993	-.60-	.75
	Expert group	Public	-.04-	.138	.995	-.42-	.35
		Policy maker	-.96-*	.305	.019	-1.82-	-.11-
		GPiE&WM	.04	.270	.999	-.72-	.79
	Policy maker	Public	.93*	.279	.012	.15	1.71
		Expert group	.96*	.305	.019	.11	1.82
		GPiE&WM	1.00	.362	.055	-.01-	2.01
	GPiE&WM	Public	-.07-	.240	.993	-.75-	.60
		Expert group	-.04-	.270	.999	-.79-	.72
		Policy maker	-1.00-	.362	.055	-2.01-	.01

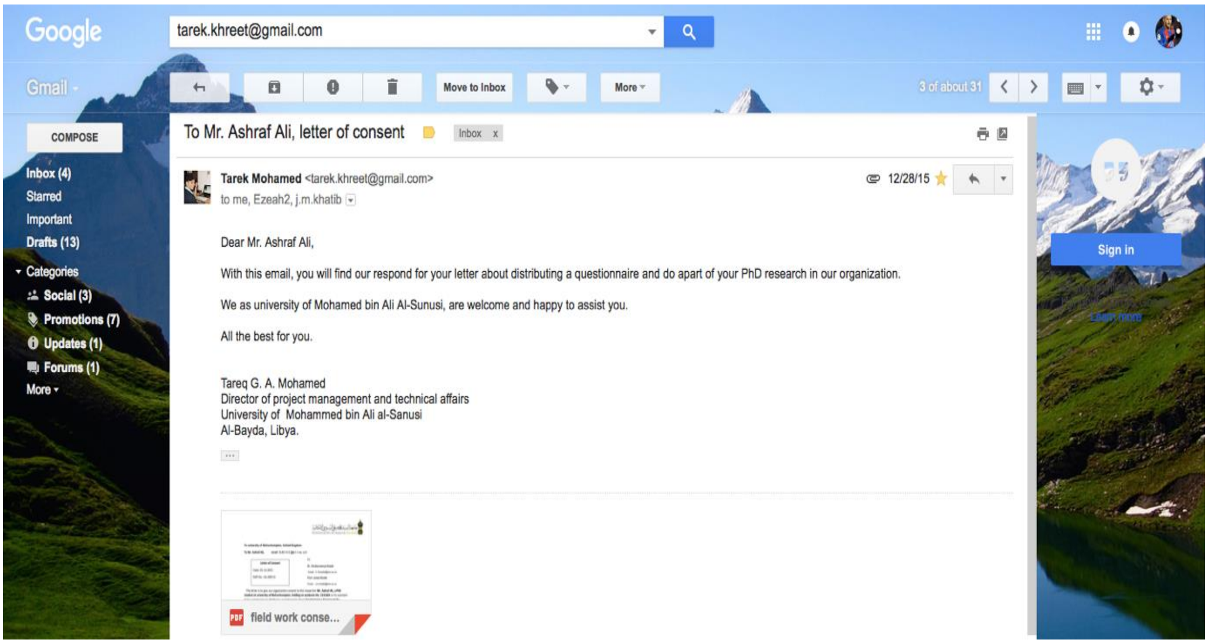
18-Lack of market competition	Public	Expert group	-.25-	.147	.393	-.67-	.16
		Policy maker	-.86-*	.297	.041	-1.69-	-.02-
		GPiE&WM	.26	.256	.794	-.46-	.98
	Expert group	Public	.25	.147	.393	-.16-	.67
		Policy maker	-.60-	.325	.332	-1.51-	.31
		GPiE&WM	.51	.288	.363	-.29-	1.32
	Policy maker	Public	.86*	.297	.041	.02	1.69
		Expert group	.60	.325	.332	-.31-	1.51
		GPiE&WM	1.12*	.387	.040	.03	2.20
	GPiE&WM	Public	-.26-	.256	.794	-.98-	.46
		Expert group	-.51-	.288	.363	-1.32-	.29
		Policy maker	-1.12-*	.387	.040	-2.20-	-.03-
19-Attitude of some construction professional such as architects and engineers	Public	Expert group	.08	.150	.956	-.33-	.50
		Policy maker	-.09-	.303	.994	-.93-	.76
		GPiE&WM	.24	.261	.844	-.49-	.97
	Expert group	Public	-.08-	.150	.956	-.50-	.33
		Policy maker	-.17-	.331	.966	-1.10-	.76
		GPiE&WM	.15	.293	.966	-.67-	.97
	Policy maker	Public	.09	.303	.994	-.76-	.93
		Expert group	.17	.331	.966	-.76-	1.10
		GPiE&WM	.32	.394	.879	-.78-	1.43
	GPiE&WM	Public	-.24-	.261	.844	-.97-	.49
		Expert group	-.15-	.293	.966	-.97-	.67
		Policy maker	-.32-	.394	.879	-1.43-	.78

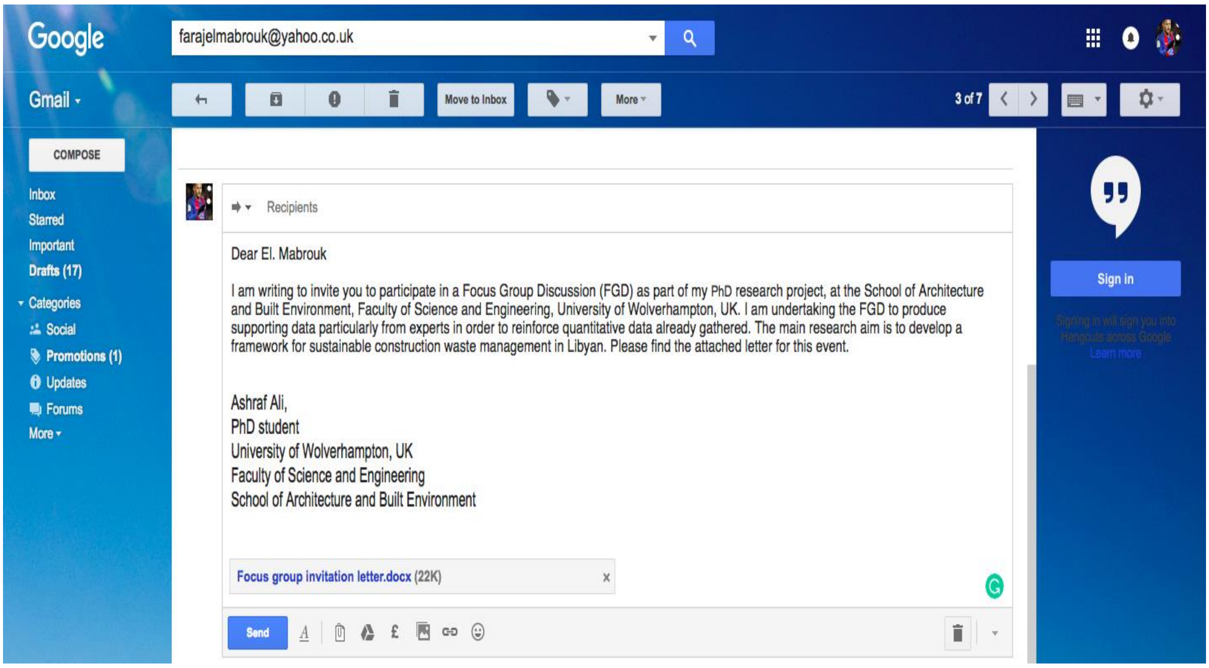
Based on observed means.
The error term is Mean Square(Error) = 2.236.

*. The mean difference is significant at the .05 level.

Appendix 11: Examples of E-Mails Sent to Participants regarding Questionnaire Survey and Focus Group Discussion





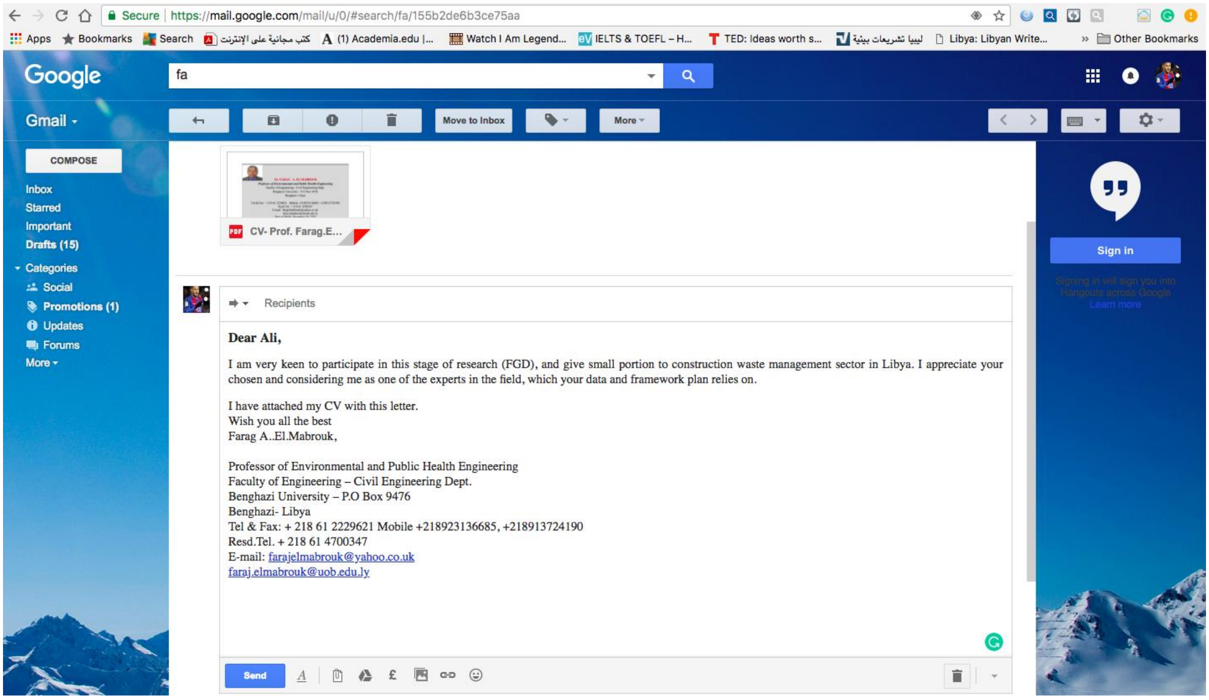


Dear El. Mabrouk

I am writing to invite you to participate in a Focus Group Discussion (FGD) as part of my PhD research project, at the School of Architecture and Built Environment, Faculty of Science and Engineering, University of Wolverhampton, UK. I am undertaking the FGD to produce supporting data particularly from experts in order to reinforce quantitative data already gathered. The main research aim is to develop a framework for sustainable construction waste management in Libyan. Please find the attached letter for this event.

Ashraf Ali,
PhD student
University of Wolverhampton, UK
Faculty of Science and Engineering
School of Architecture and Built Environment

Focus group invitation letter.docx (22K)



Dear Ali,

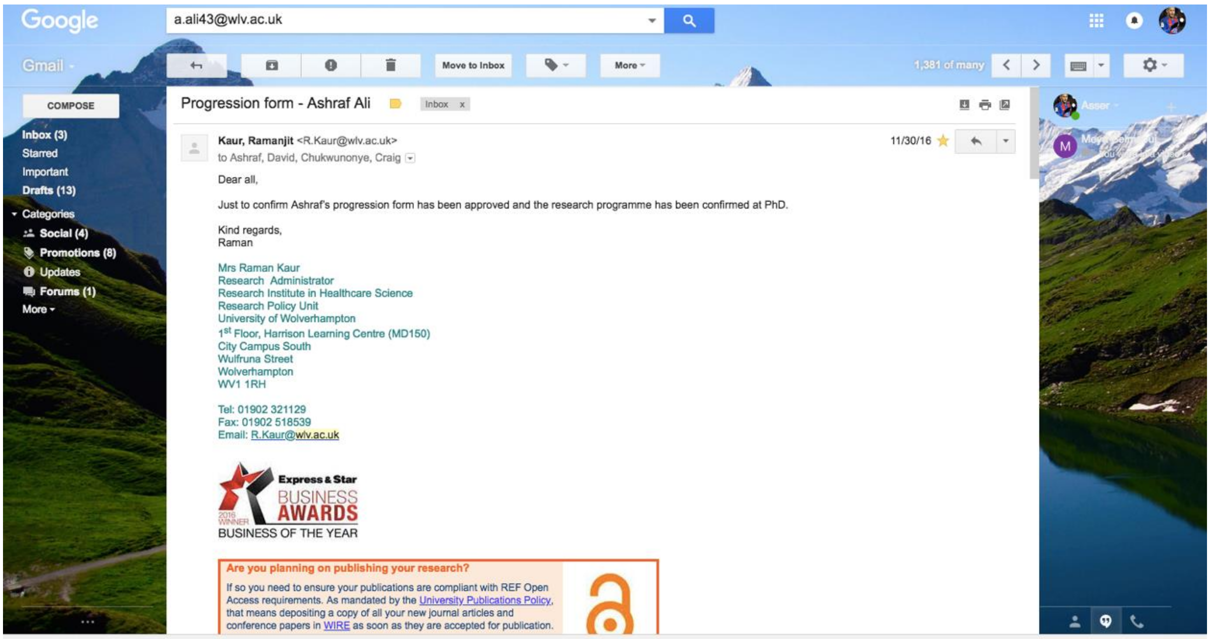
I am very keen to participate in this stage of research (FGD), and give small portion to construction waste management sector in Libya. I appreciate your chosen and considering me as one of the experts in the field, which your data and framework plan relies on.

I have attached my CV with this letter.
Wish you all the best
Farag A..El.Mabrouk,

Professor of Environmental and Public Health Engineering
Faculty of Engineering – Civil Engineering Dept.
Benghazi University – P.O Box 9476
Benghazi- Libya
Tel & Fax: + 218 61 2229621 Mobile +218923136685, +218913724190
Resd.Tel. + 218 61 4700347
E-mail: farajelmabrouk@yahoo.co.uk
faraj.elmabrouk@uob.edu.ly

Appendix 12: Progression from M.Phil to Ph.D.

Progression from M.Phil. to Ph.D. (30 November 2016)



Progression form - Ashraf Ali

Kaur, Ramanjit <R.Kaur@wlv.ac.uk> 11/30/16
to Ashraf, David, Chukwunonye, Craig

Dear all,

Just to confirm Ashraf's progression form has been approved and the research programme has been confirmed at PhD.

Kind regards,
Raman

Mrs Raman Kaur
Research Administrator
Research Institute in Healthcare Science
Research Policy Unit
University of Wolverhampton
1st Floor, Harrison Learning Centre (MD150)
City Campus South
Wulfruna Street
Wolverhampton
WV1 1RH

Tel: 01902 321129
Fax: 01902 518539
Email: R.Kaur@wlv.ac.uk

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